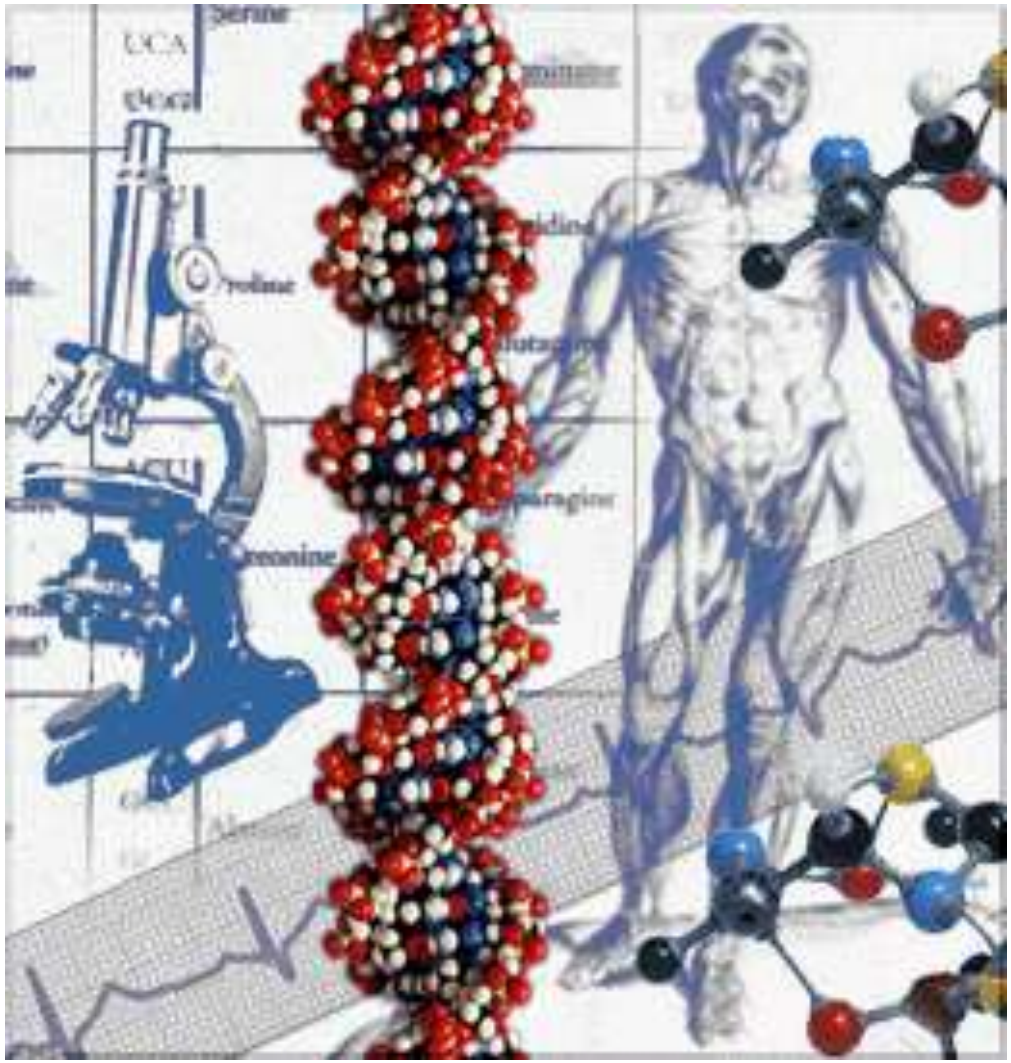
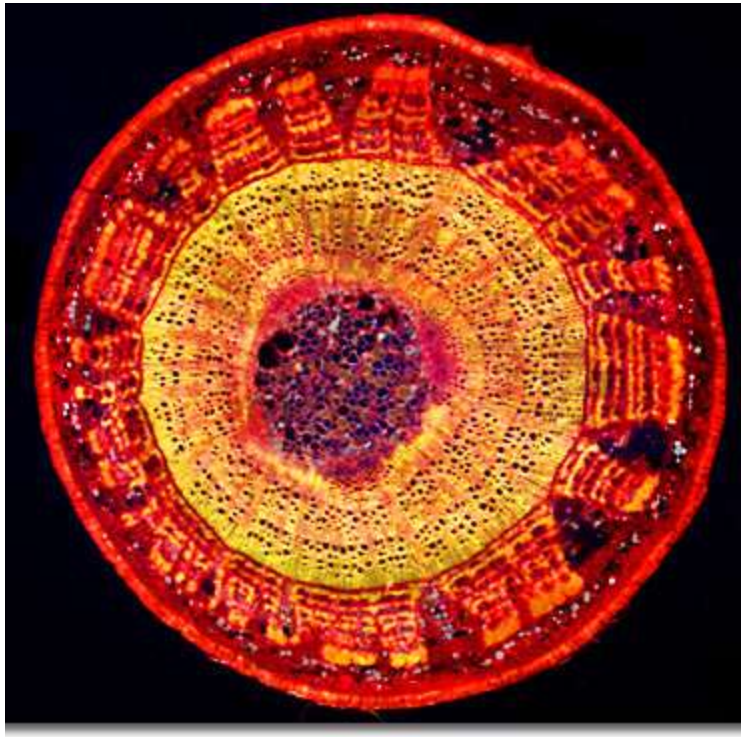
Chapter 3

Genetics: Reproducing Life and Producing Variation

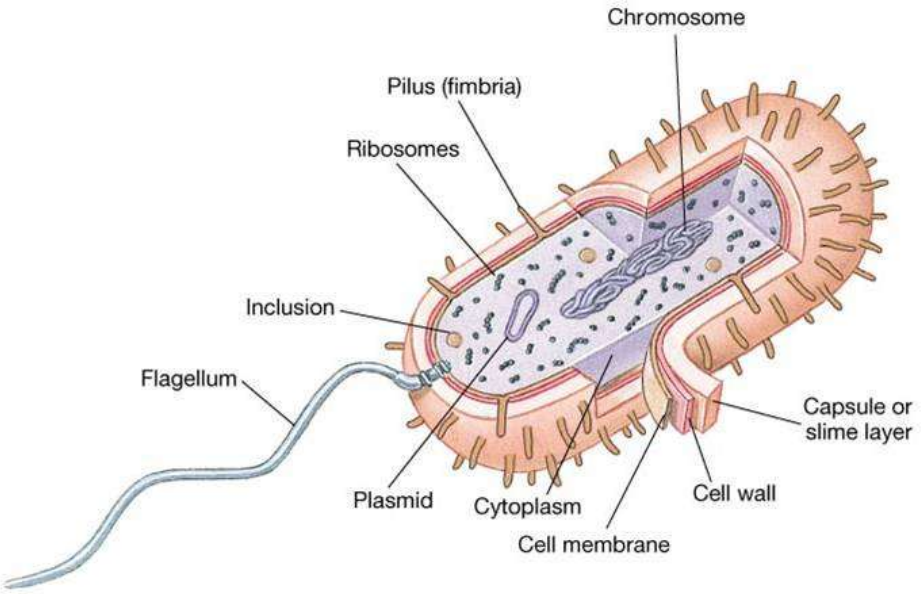


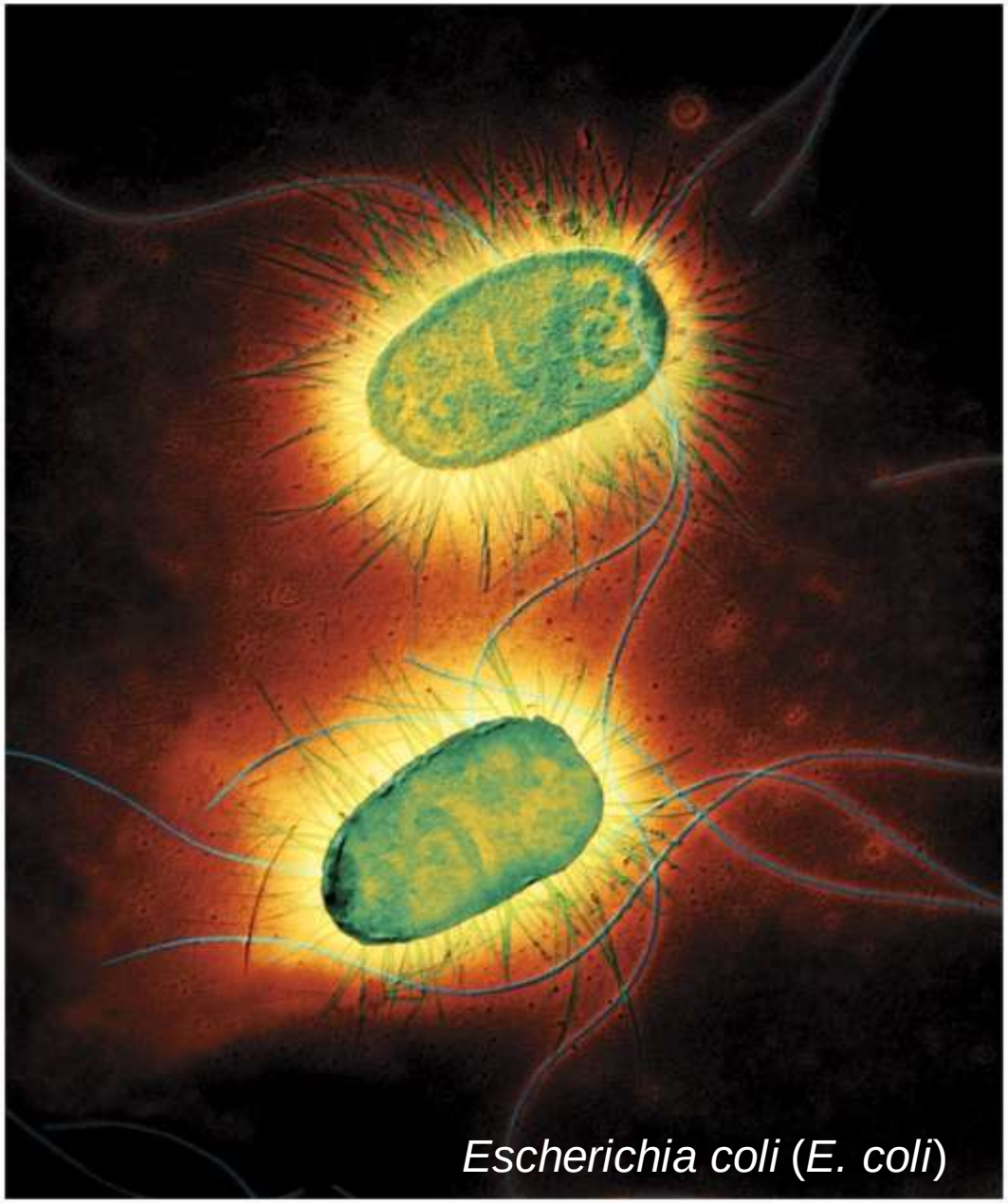


Cytology: The Study of Cells

- basic units of life
- Complex life forms are made up of billions of cells.
- cells of all organisms share many similarities as a result of their common evolutionary past.

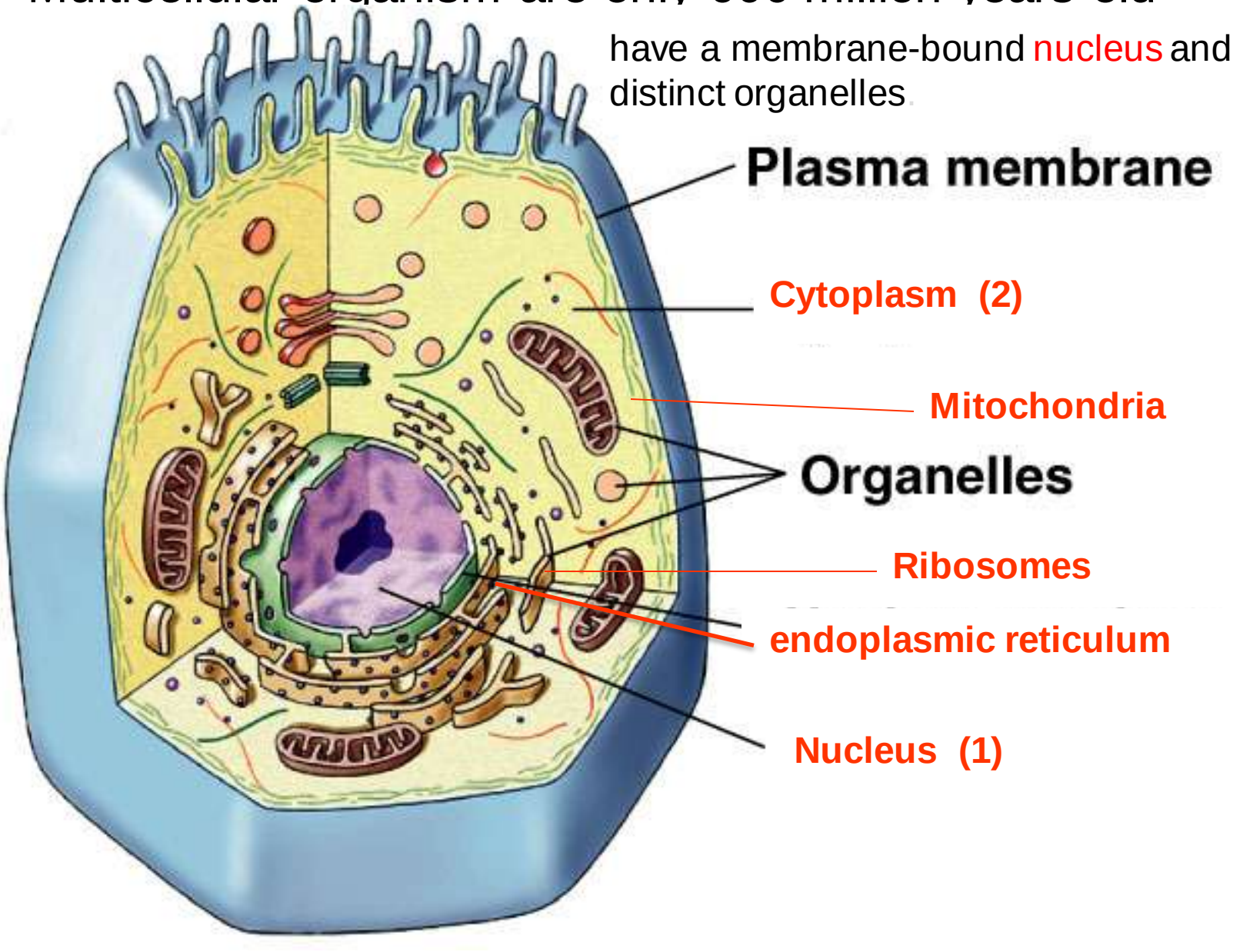
Prokaryotic cells:
3.7 billion years old




Escherichia coli (*E. coli*)

- Eukaryotic cells 1.2 billion years old
  - Multicellular organism are only 600 million years old

have a membrane-bound nucleus and distinct organelles.

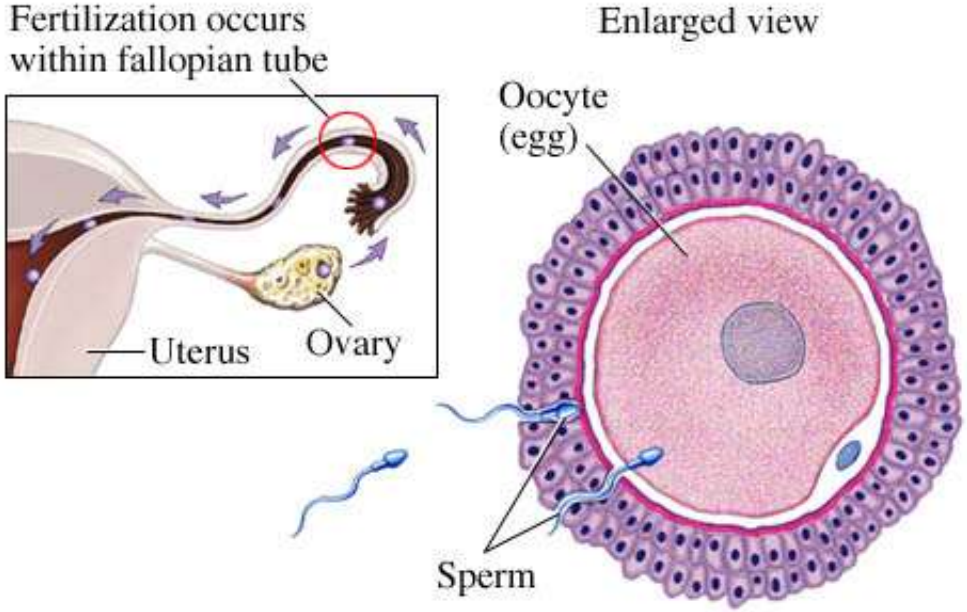


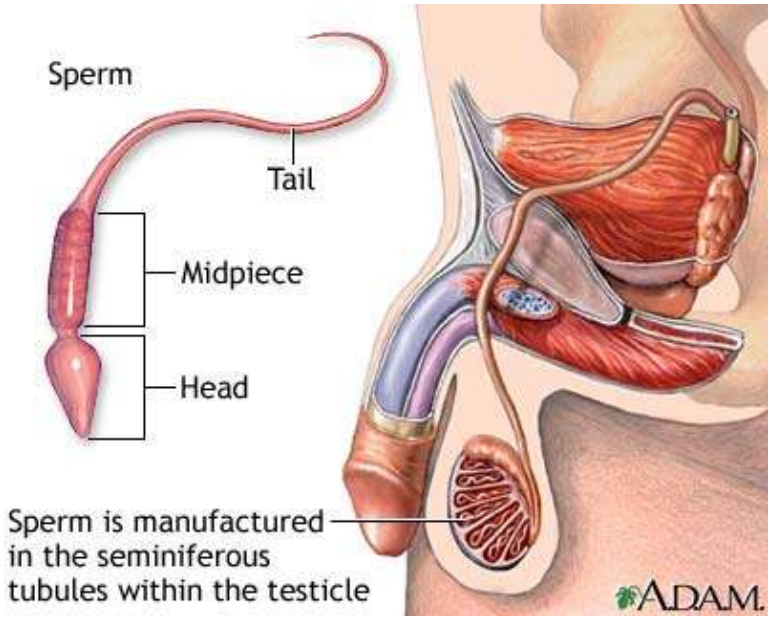
Two Types of Cells

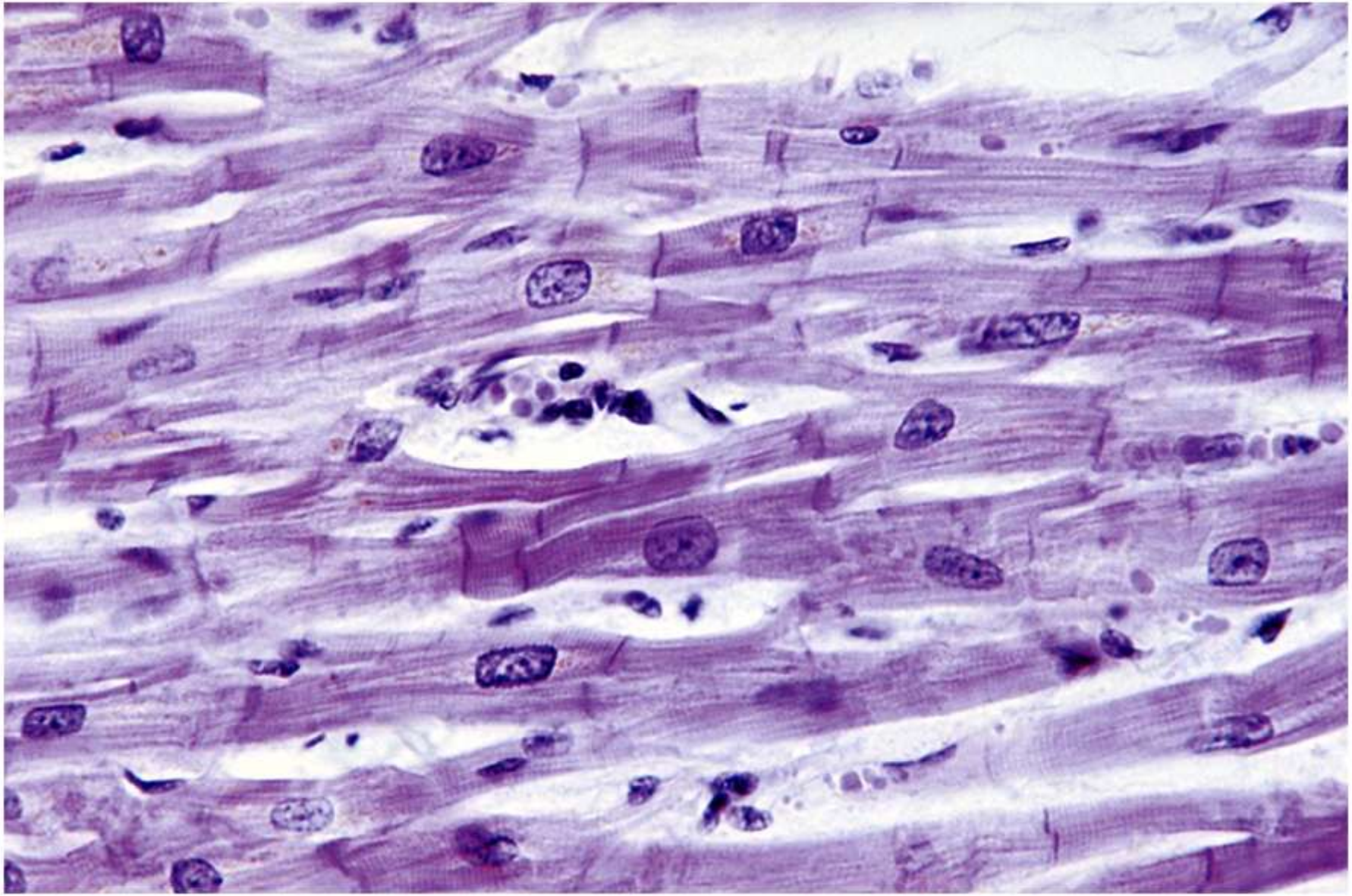
- **Somatic** cells are the components of body tissues.
- **Gametes** are sex cells.

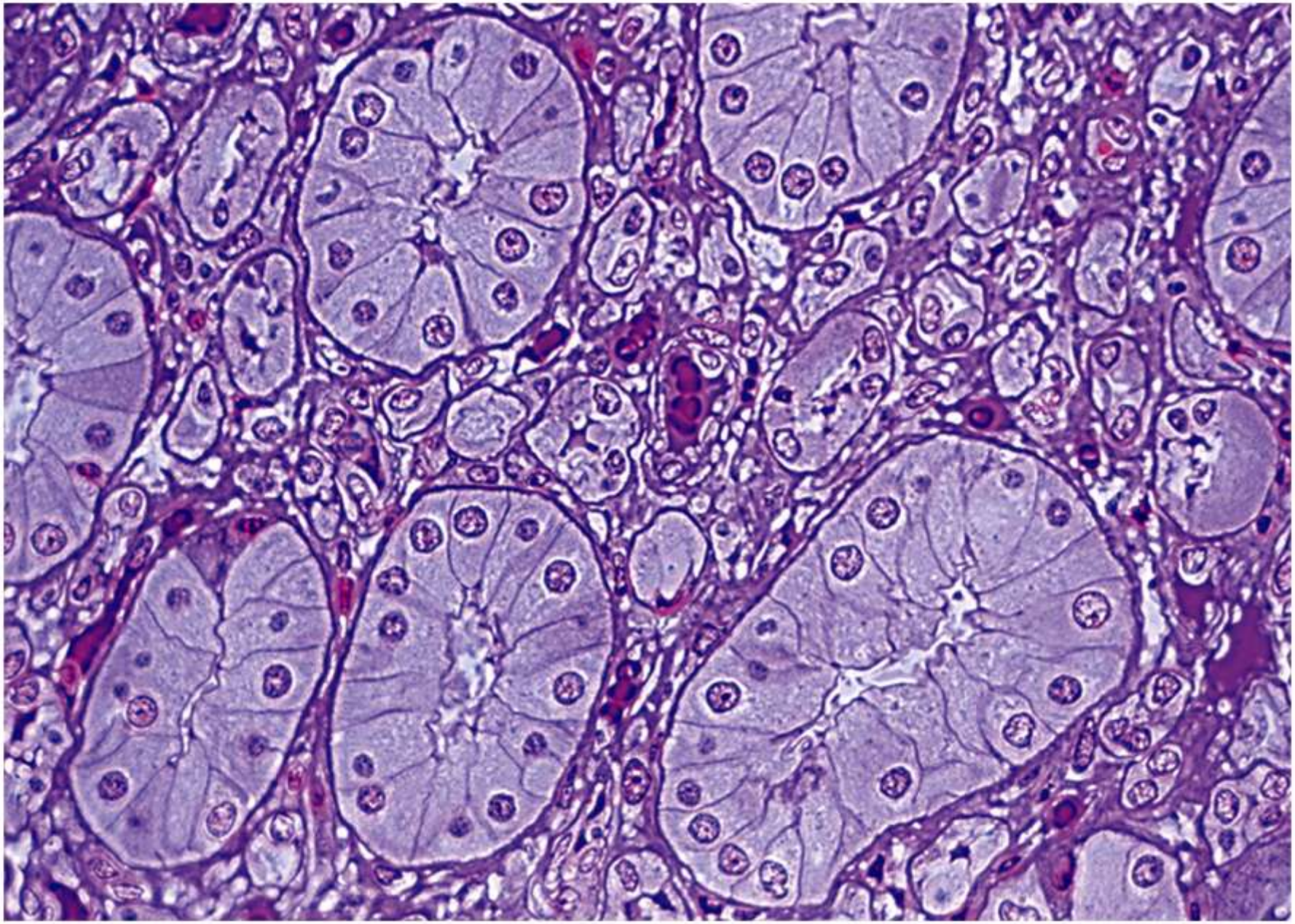
Ova (oocytes) are egg cells produced in female ovaries.

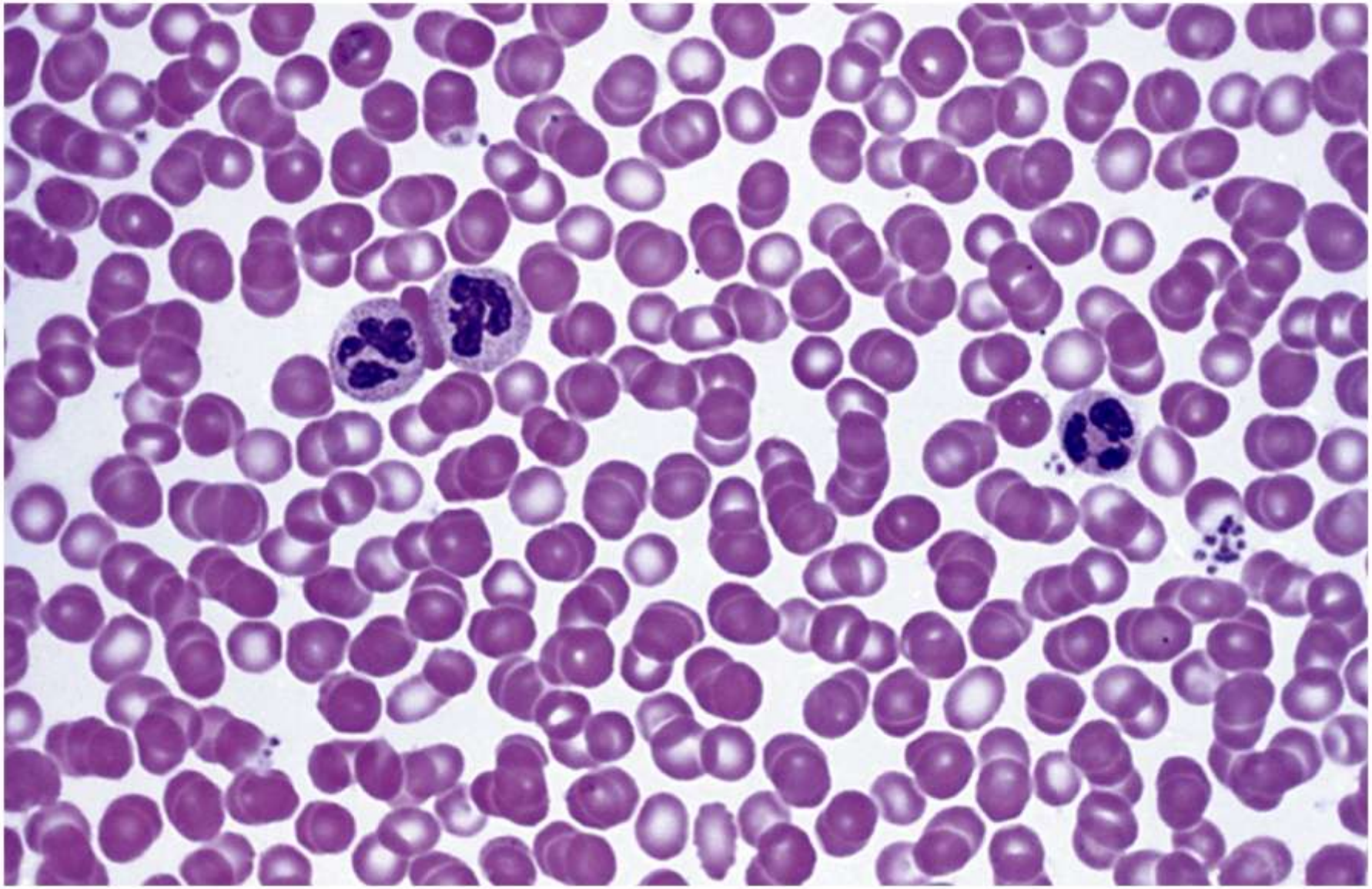
Sperm (spermatocytes) are sex cells produced in male testes.

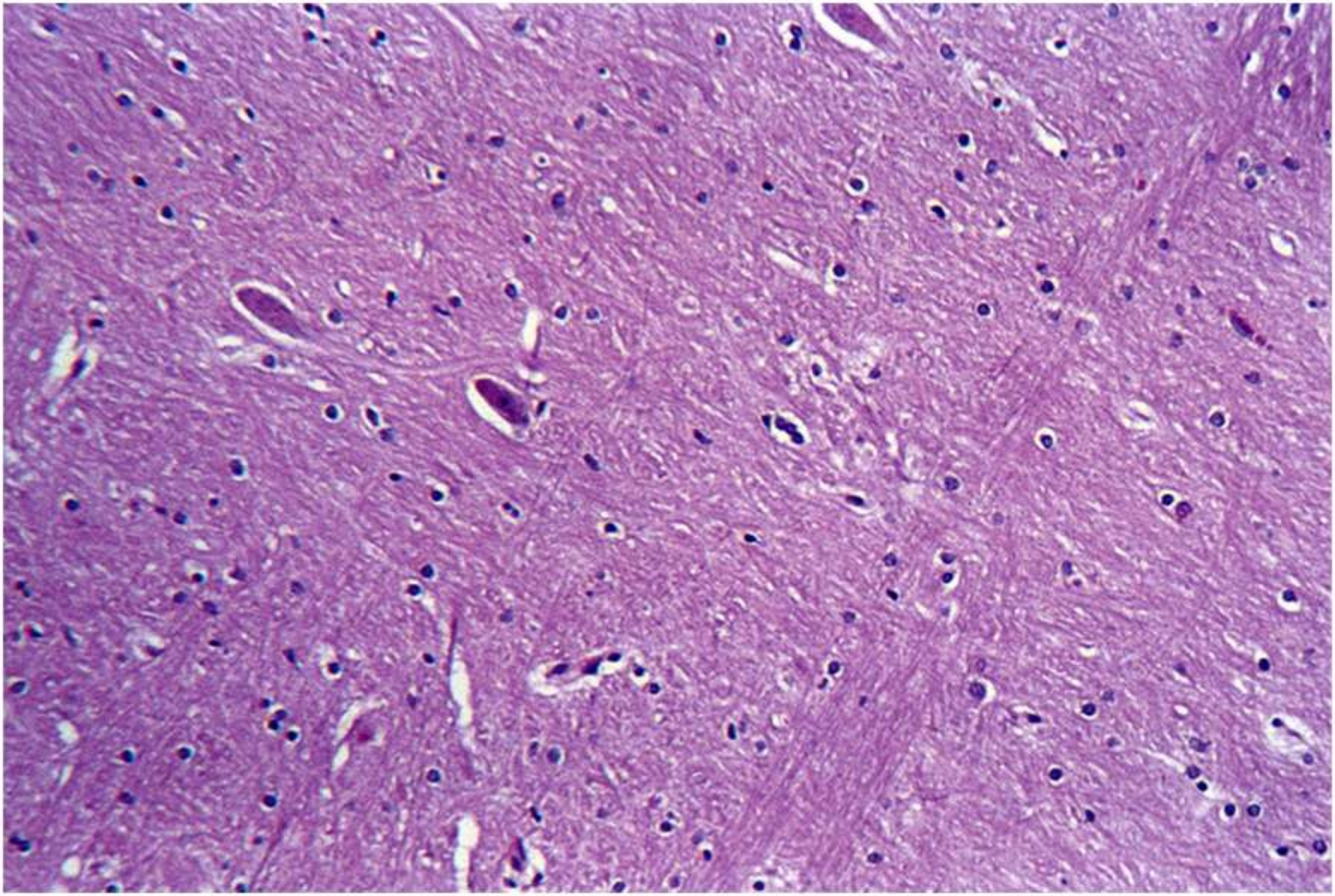


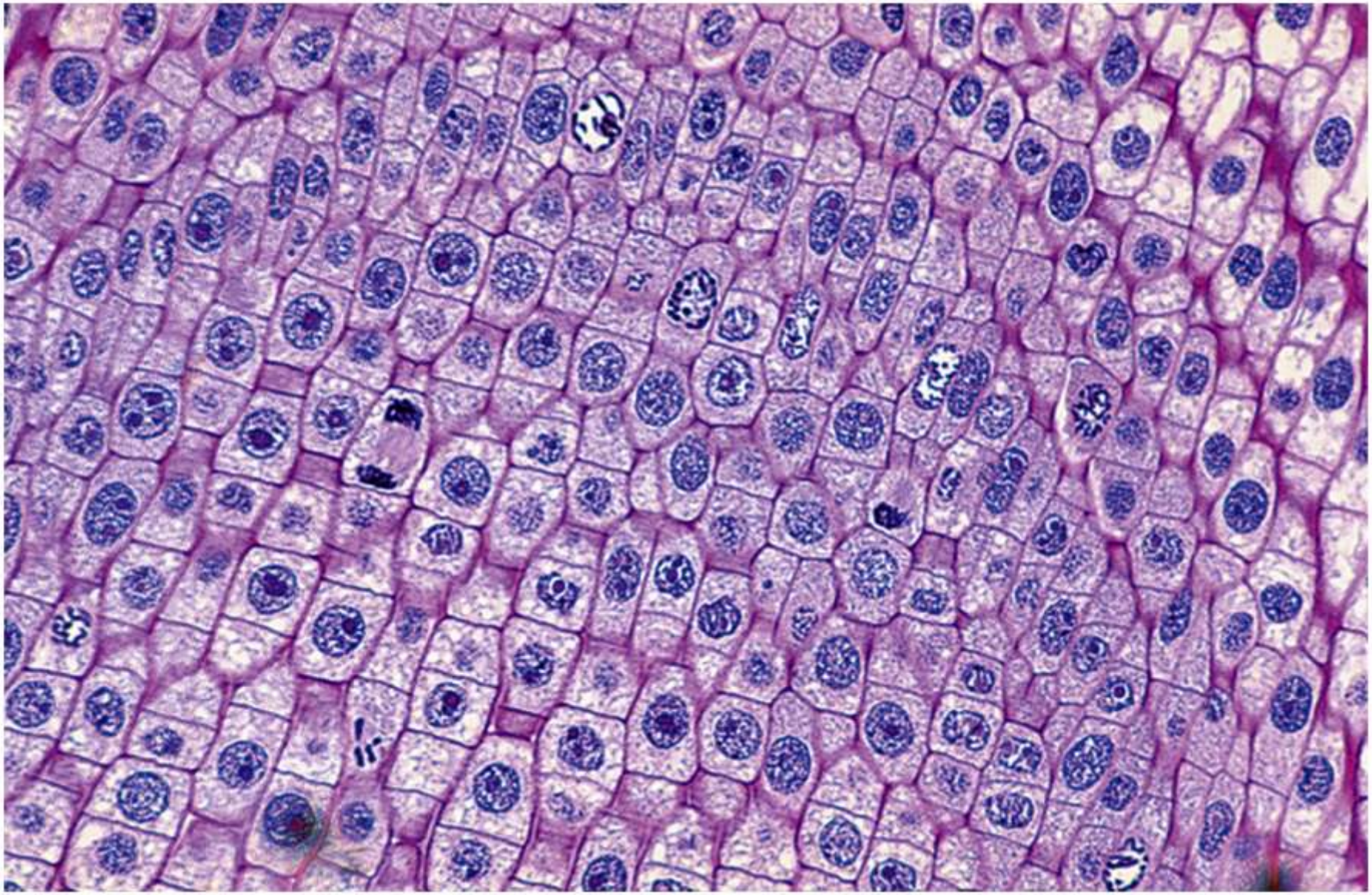


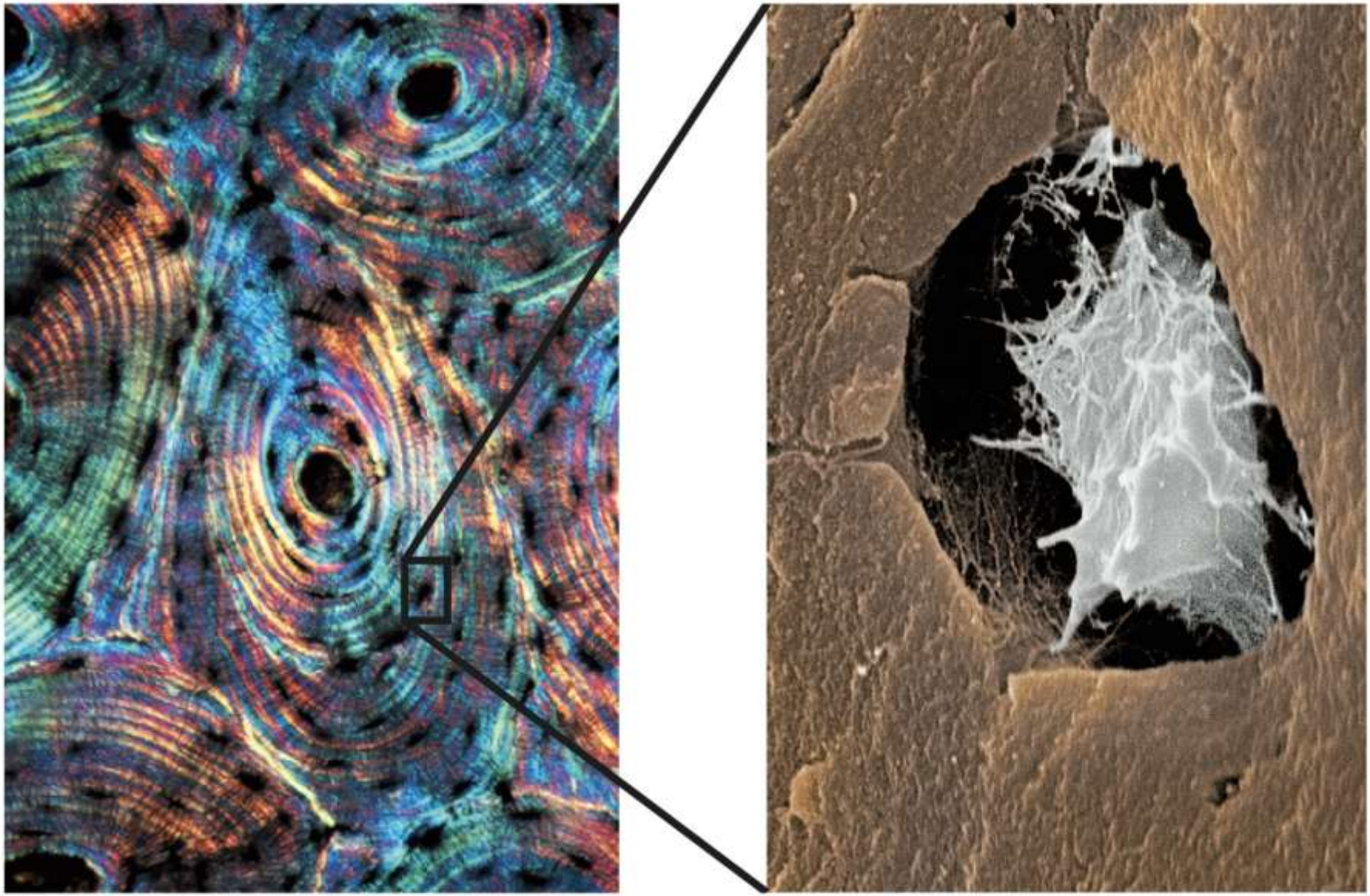












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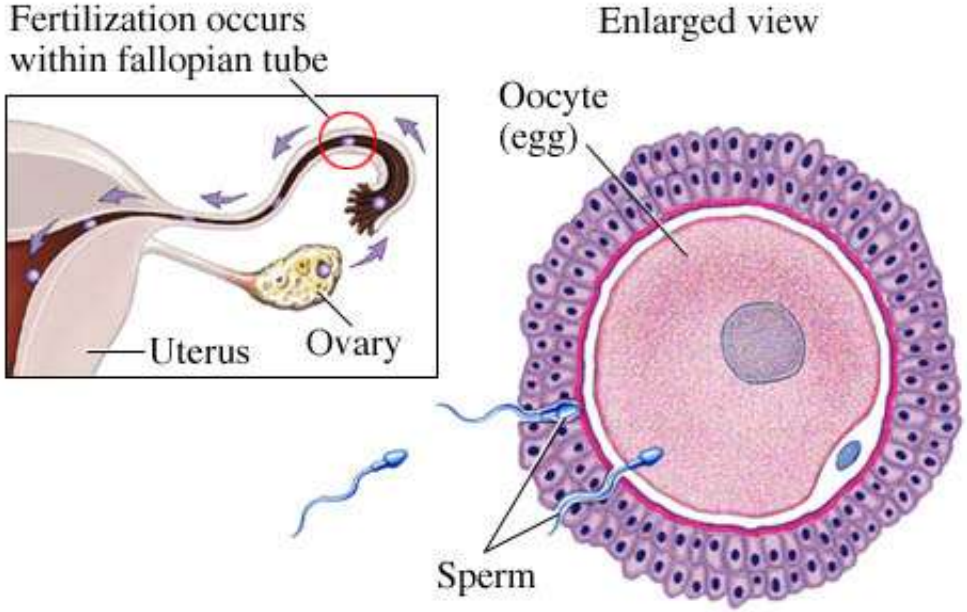
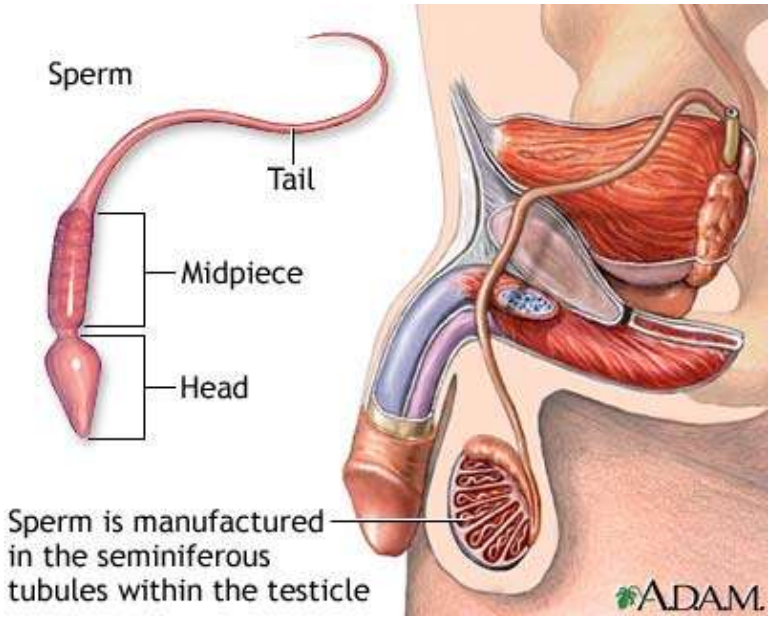
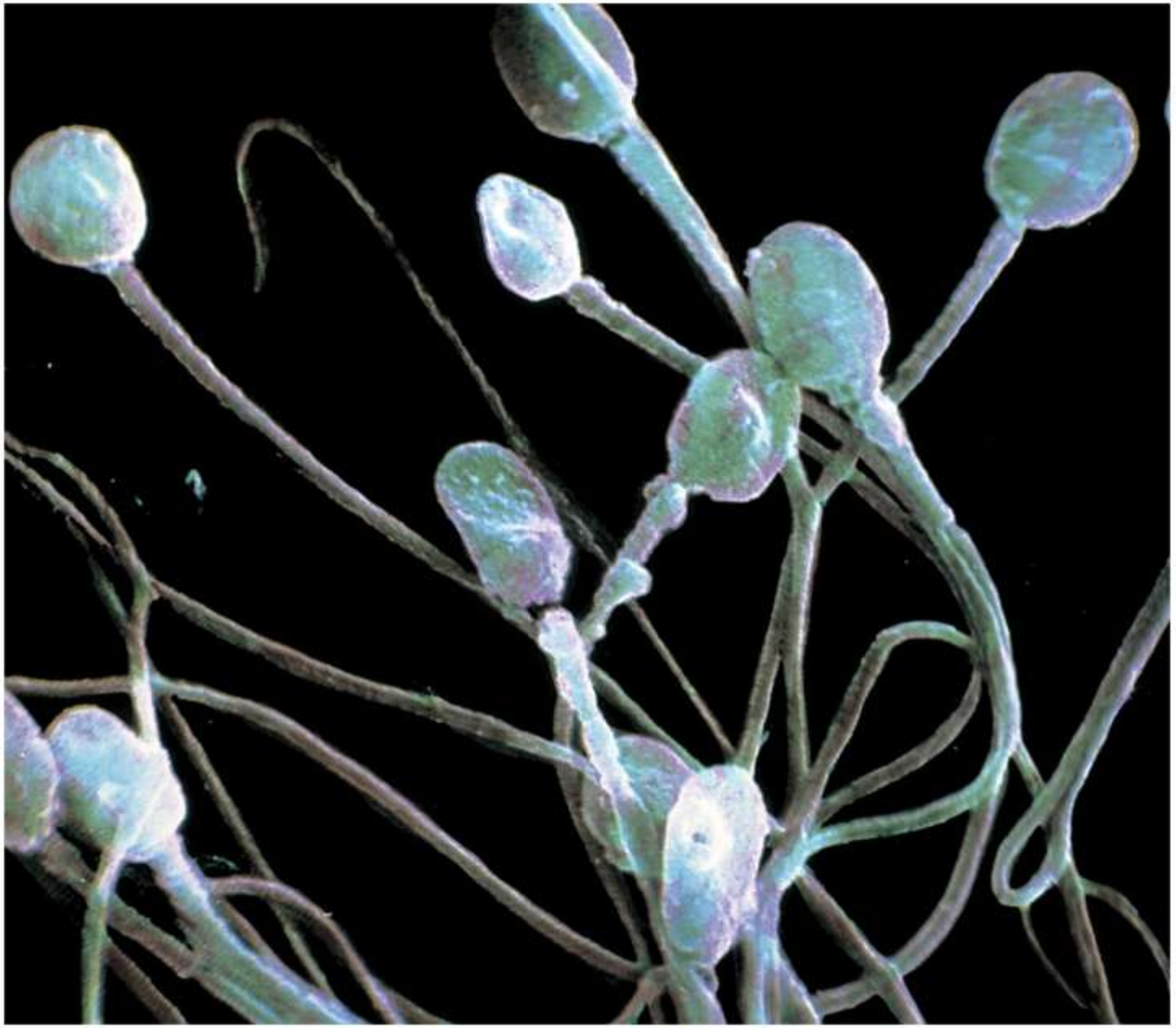
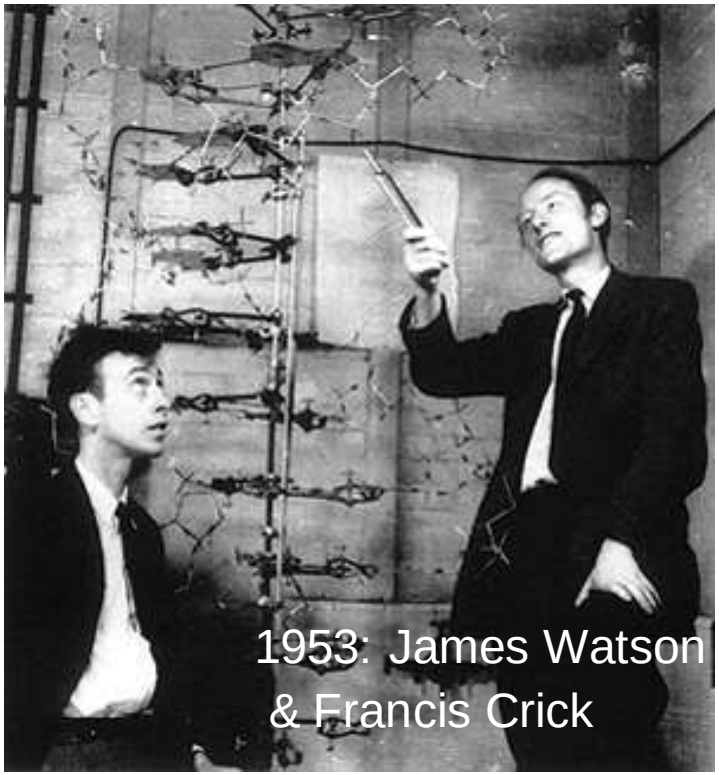




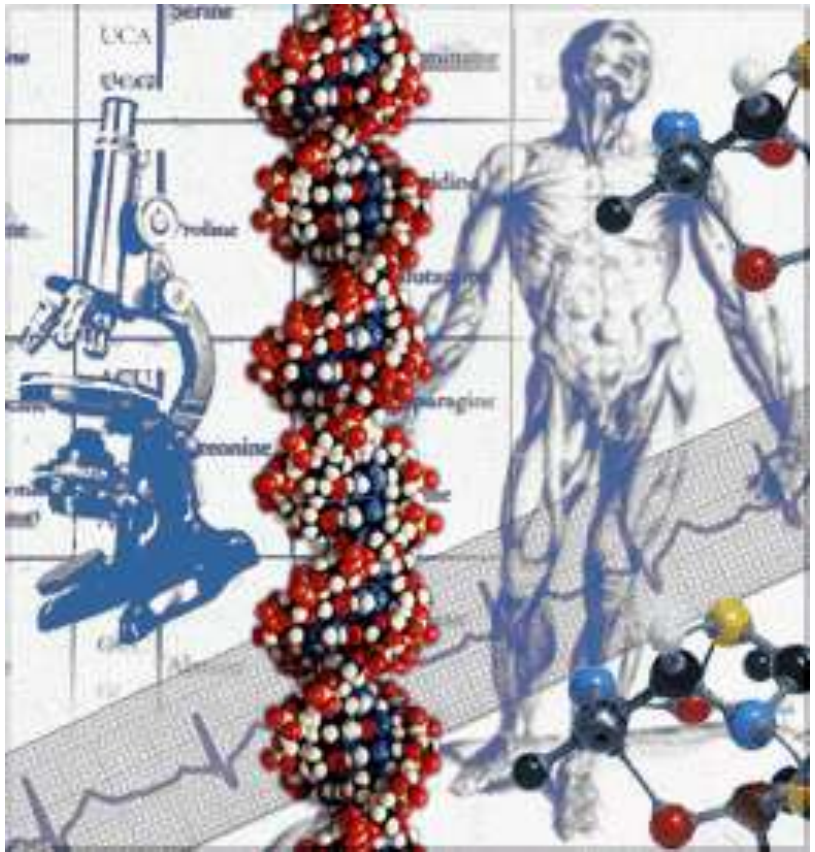


DNA Molecule: The Genetic Code



Genome

homoplasmic

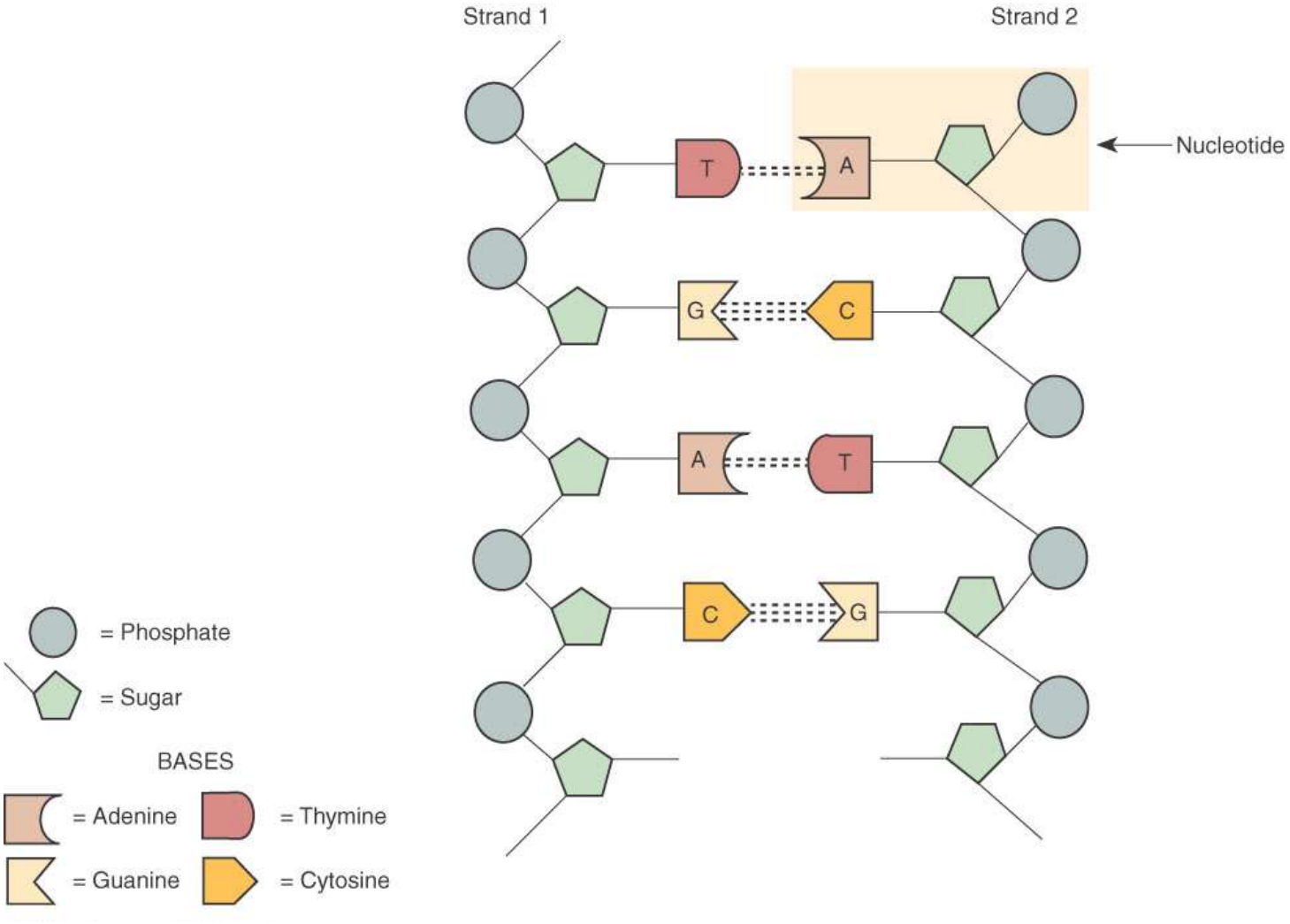


The DNA molecule 3 talents:

1. Replicate
2. Synthesize
3. Regulate

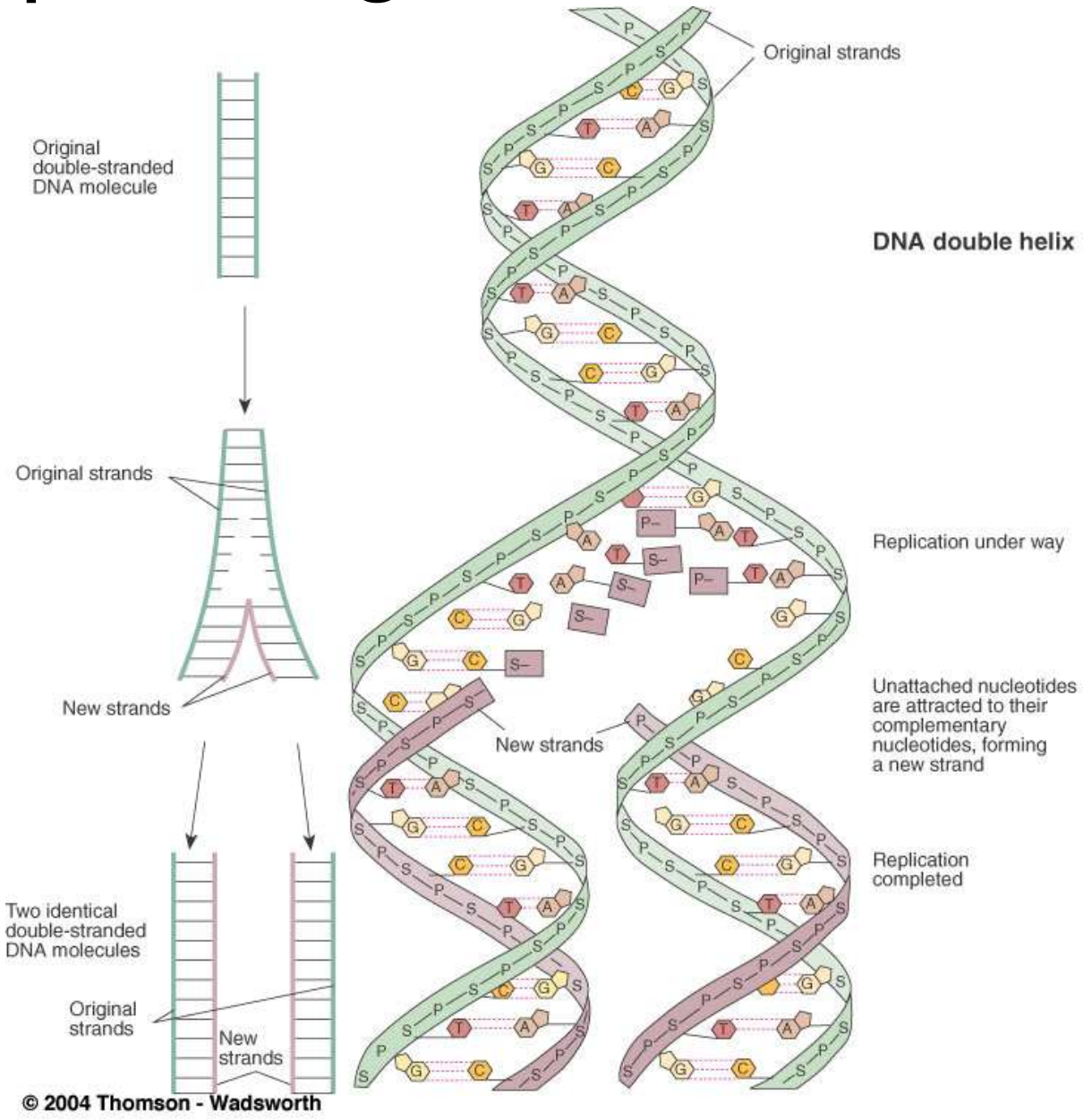
DNA: The Blueprint of Life

Nucleotides: deoxyribose sugar, a phosphate group, and one of four nitrogenous complimentary bases.



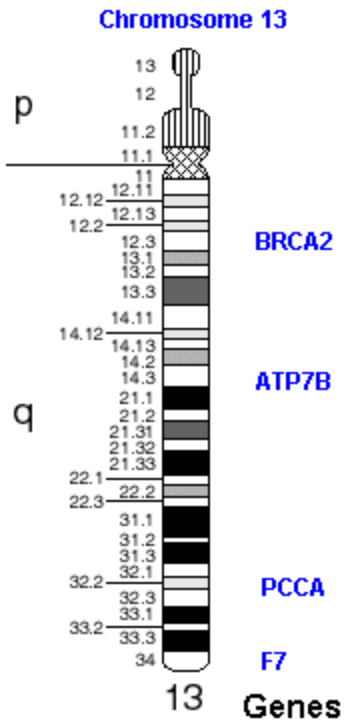
DNA: Replicating the Code

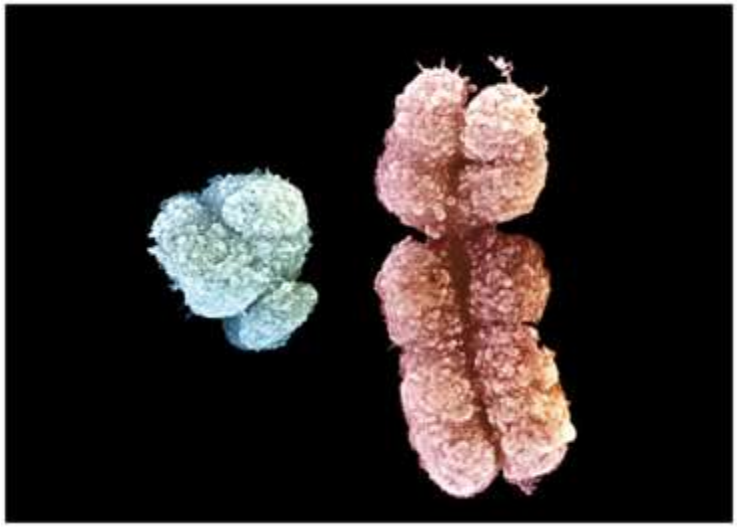
Replication takes place during mitosis and meiosis

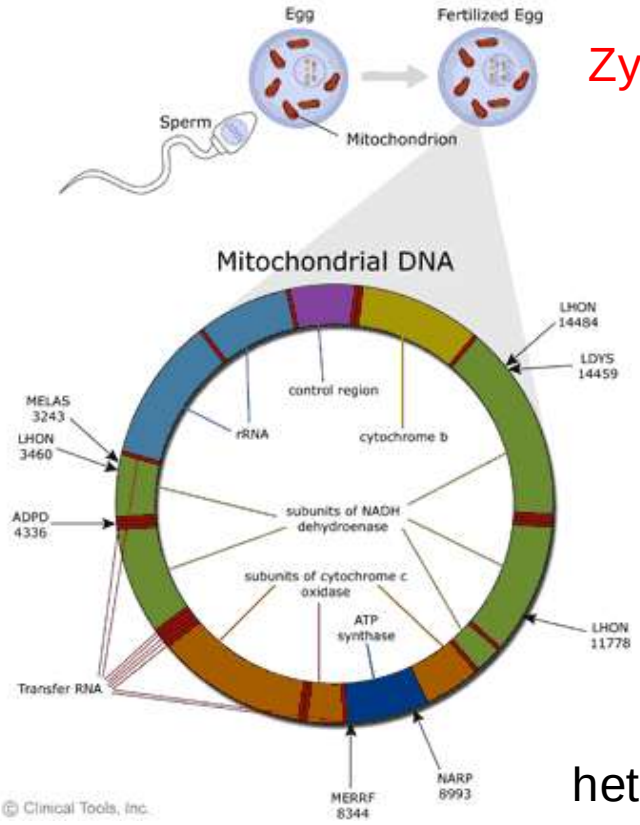


Chromosome Types

- Each species is characterized by a specific number of **chromosomes**.
  - Humans have 46 chromosomes. (Haploid/Diploid)
- Chromosome pairs are called **homologous**.
  - carry genetic information influencing the traits.
  - not genetically identical.
    - The locus is the location of a gene on a chromosome. ABO locus is on chromosome 9.
    - Alleles, homozygous, heterozygous







Zygote

heteroplasmic

Camel: 70

Guinea pig: 64

Salamander: 24

House fly: 12

Apple: 34

Potato: 48

Petunia: 14

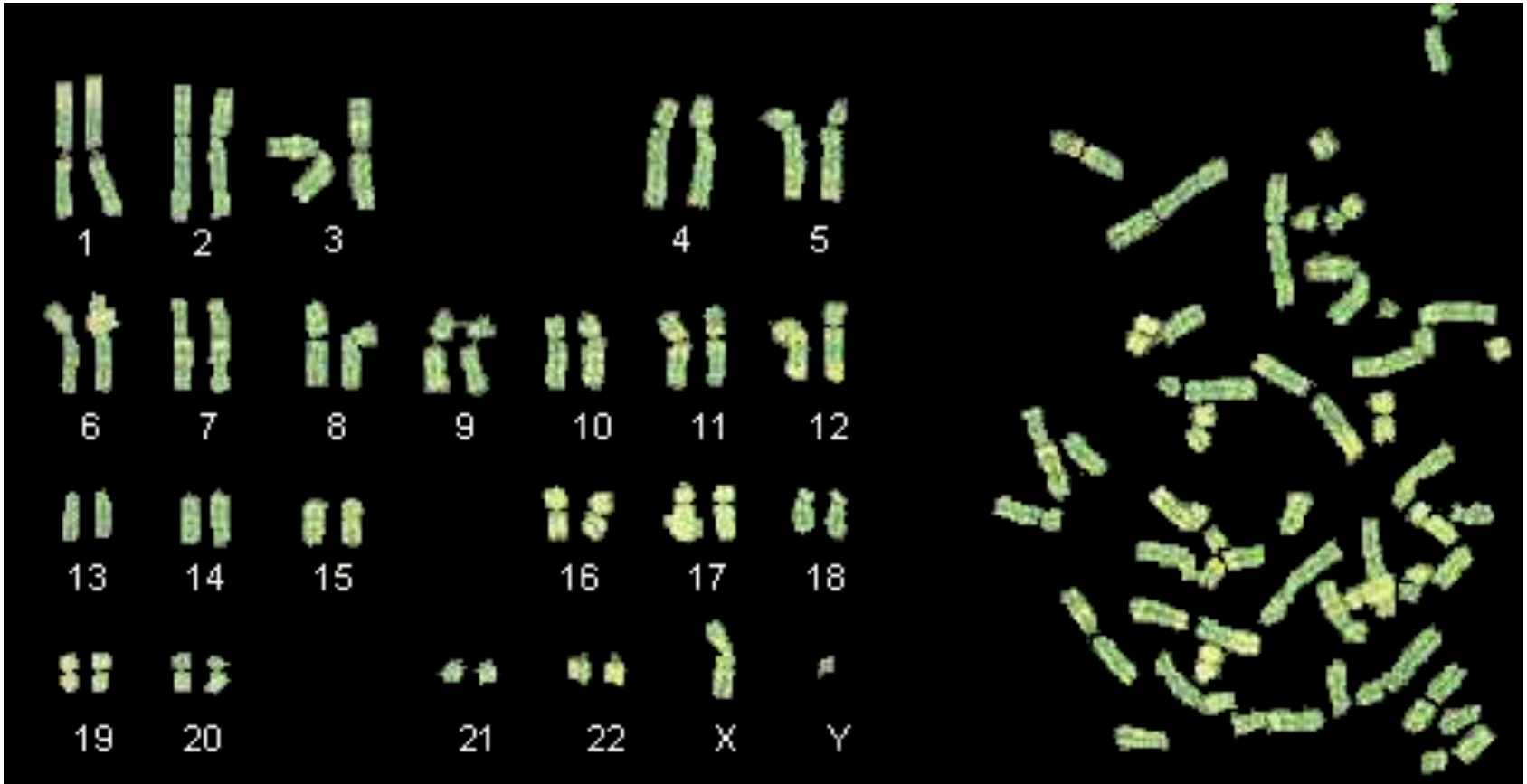
Algae: 148

Ring-tailed lemur: 56

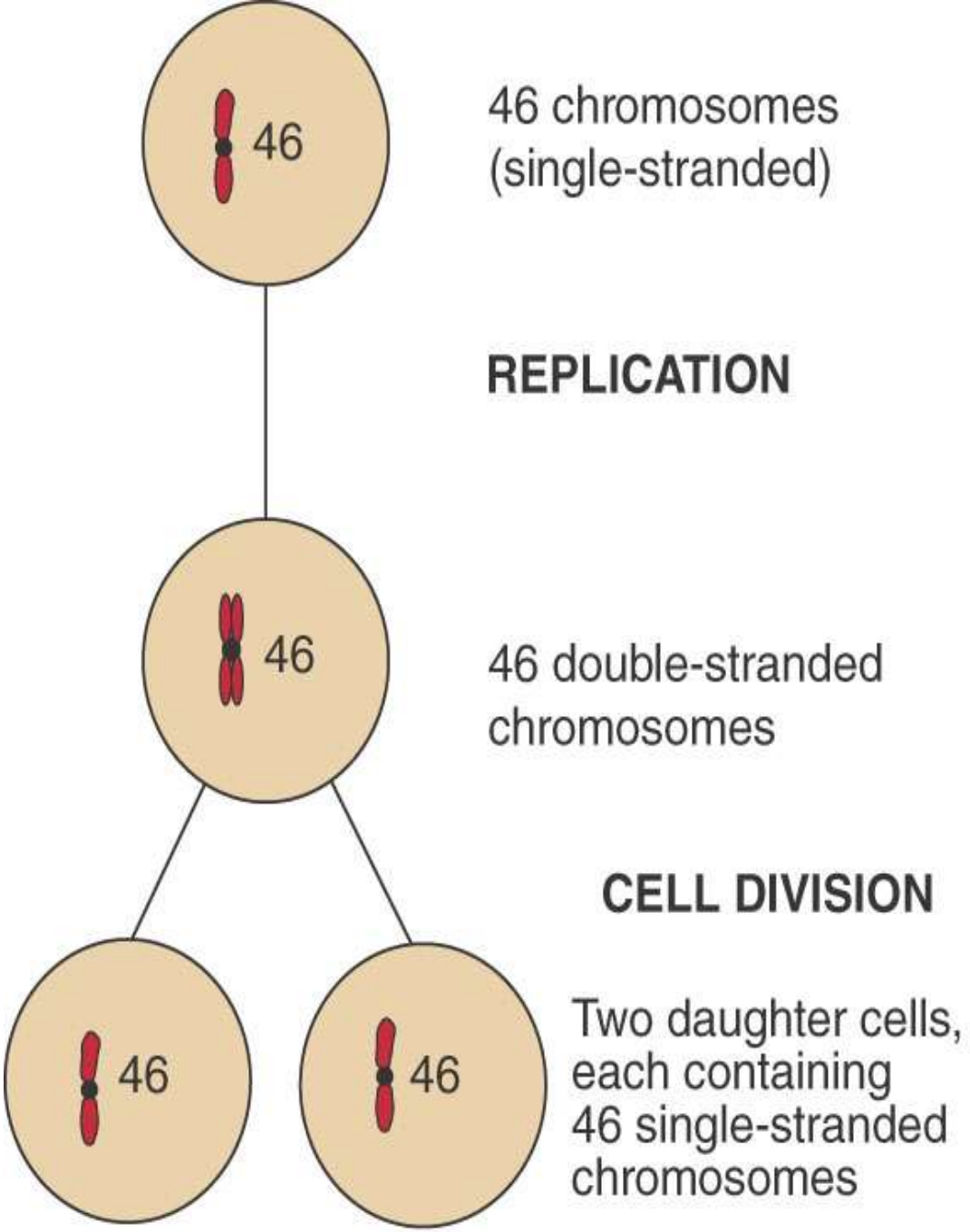
Black-and-white colobus monkey: 44

Orangutan: 48

- **Autosomes** - govern all physical characteristics except sex determination.
- **Sex chromosomes** - X and Y chromosome (mammals).
- **Karyotype**- position of centromere, banding patterns



Mitosis: Production of Identical Somatic Cells



Meiosis: Production of Gametes (sex cells)

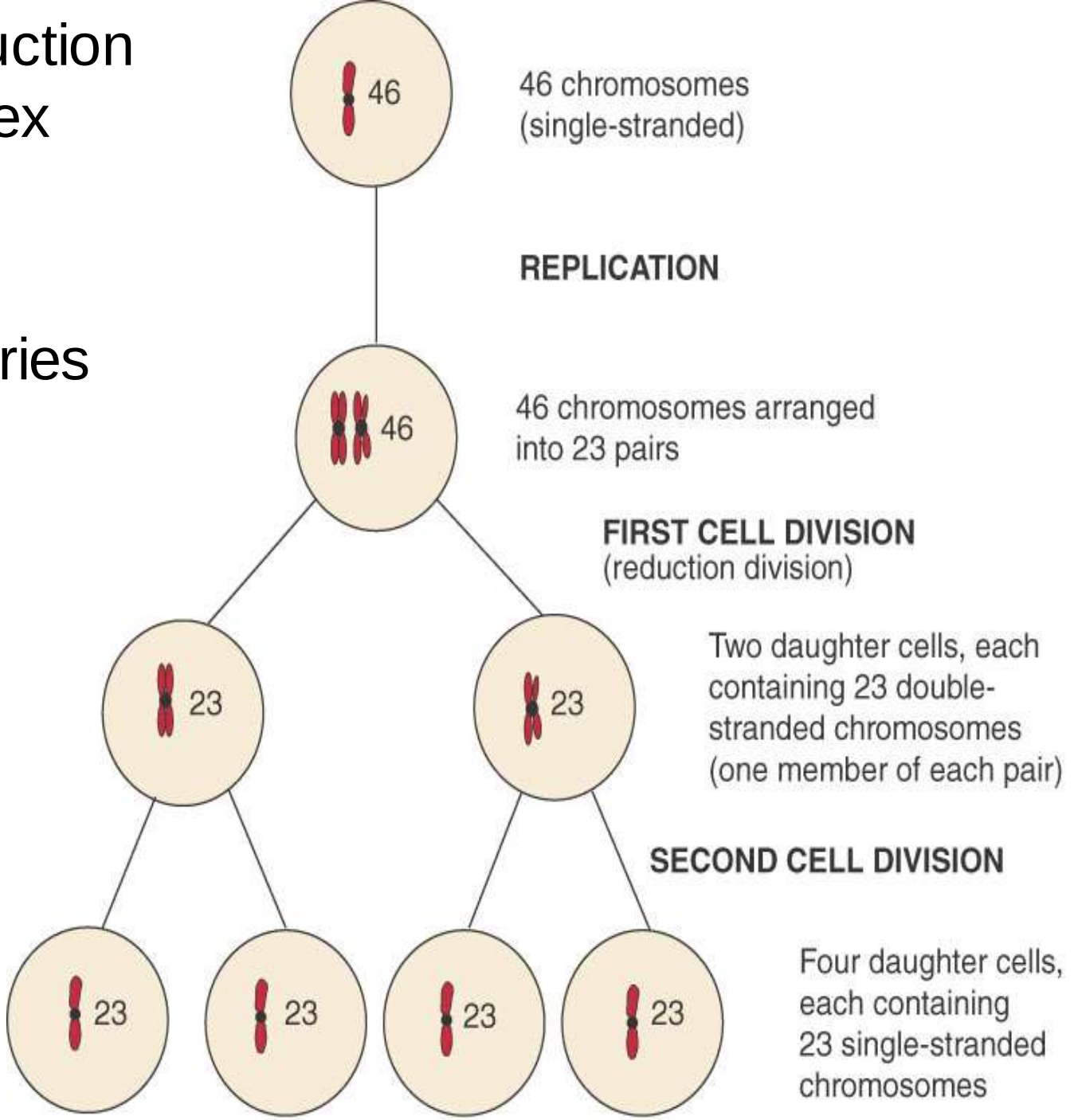
- only in the ovaries and the testes.

223 = 8,388,608

8,388,608 x 8,388,608

= 70,000,000,000,000

Animation



Evolutionary Significance of Meiosis

- Meiosis (and sex) produce variation

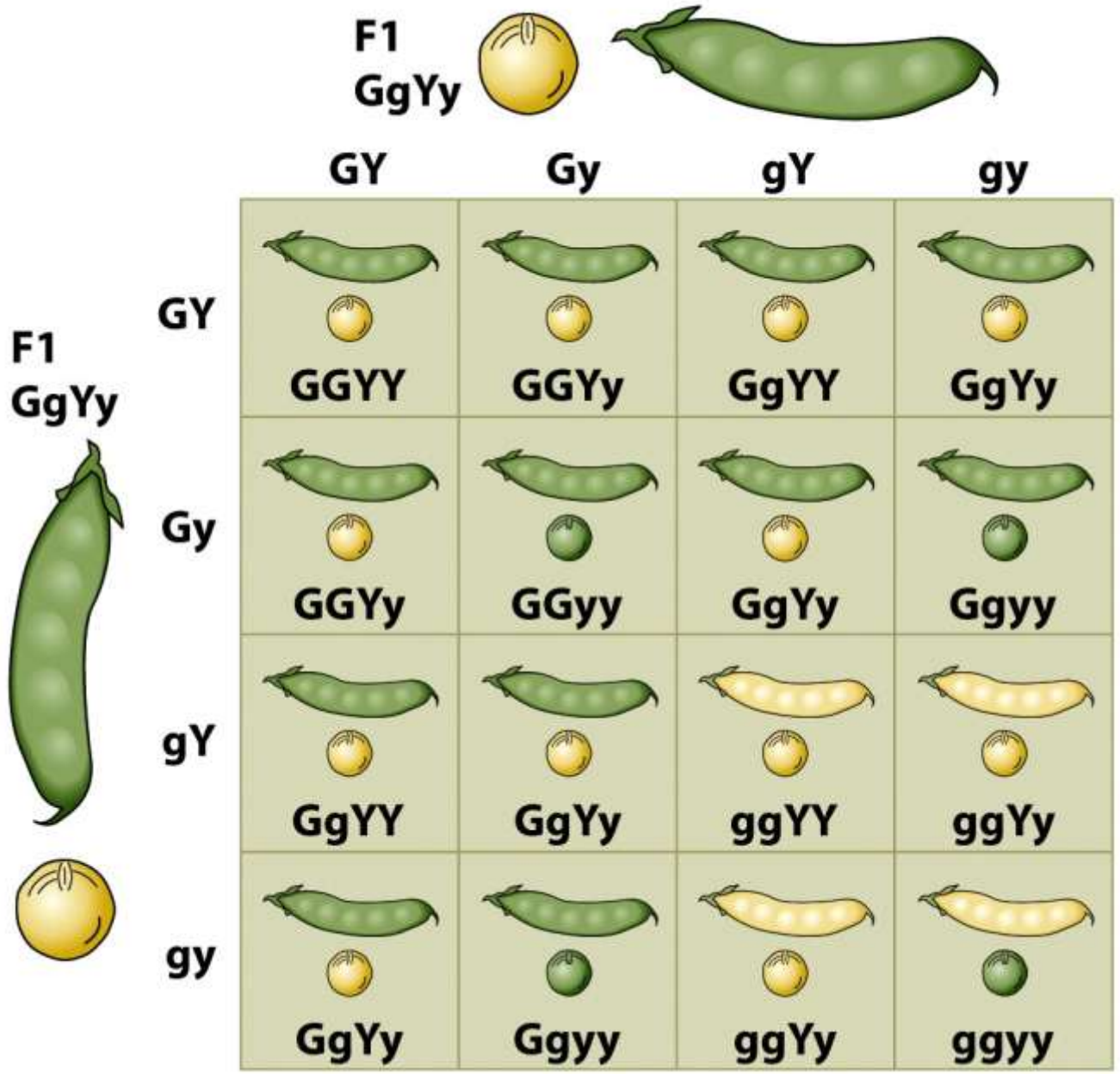
- Faster than mutation.
  - The random assortment results in 8 million possible gametes.
    - 70 trillion when mating

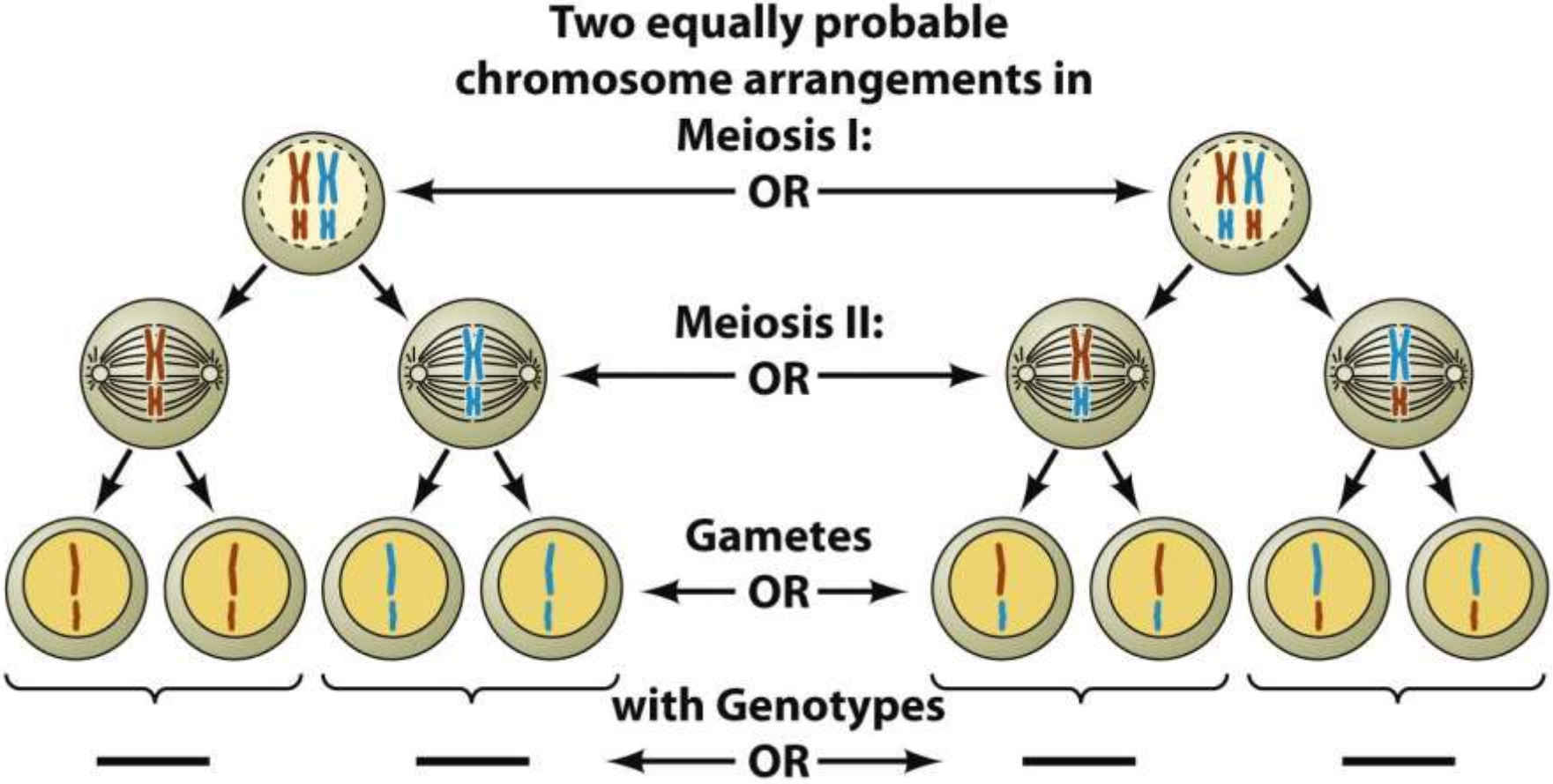
$2^{23} = 8{,}388{,}608$

$8{,}388{,}608 \times 8{,}388{,}608 = 70{,}000{,}000{,}000{,}000$

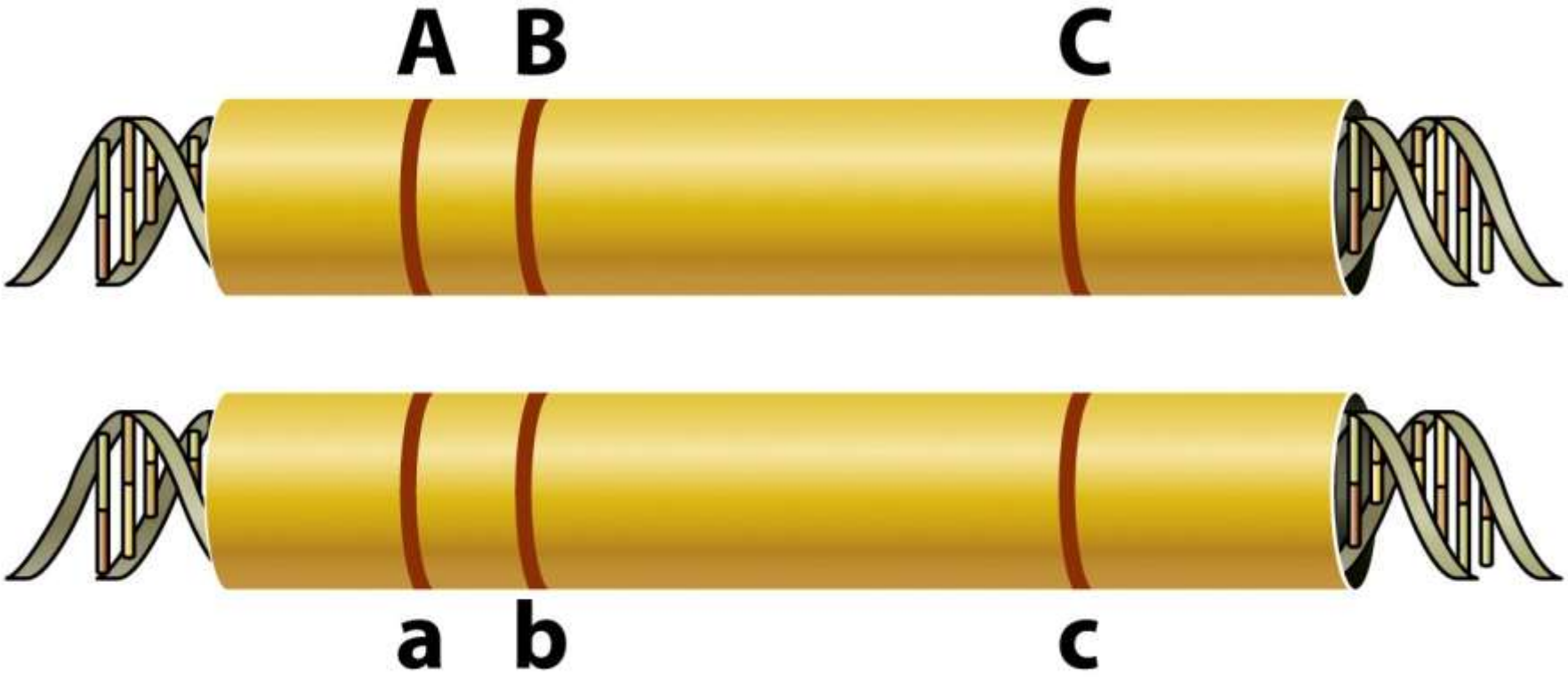
    - Cross- over produces recombination: also provides genetic diversity for natural selection to act on.

Law of Independent Assortment



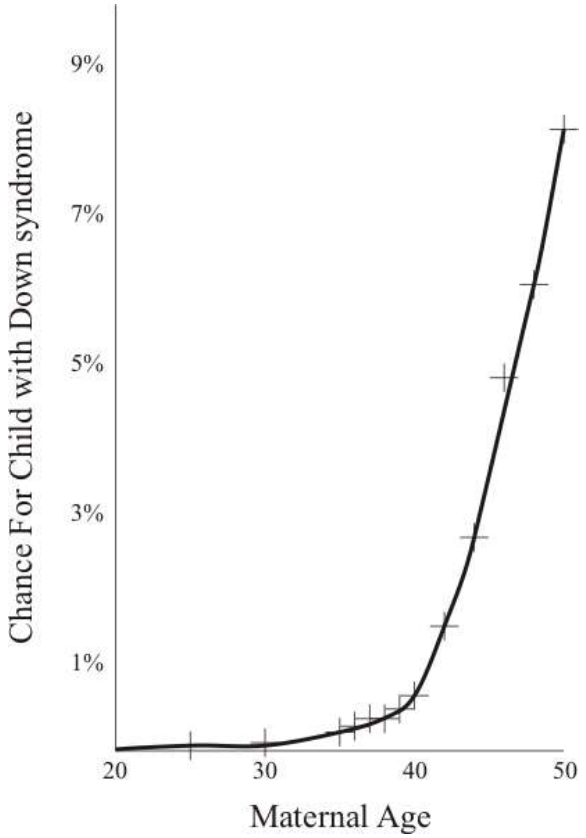

Two equally probable
chromosome arrangements in
Meiosis I:
OR
Meiosis II:
OR
Gametes
OR
with Genotypes
OR

Linkage



Problems With Meiosis

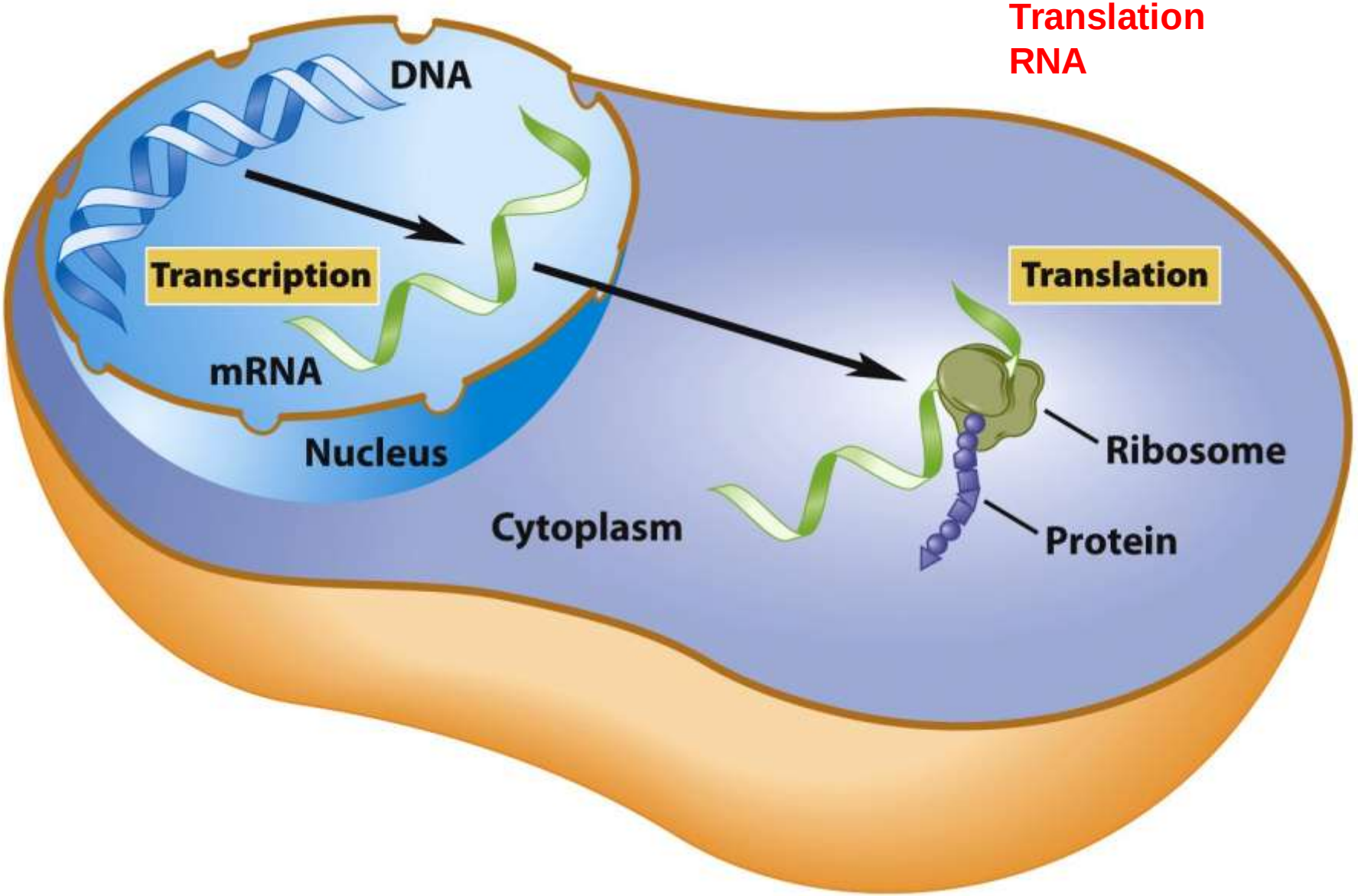
- **Nondisjunction** errors
- About 50% of pregnancies miscarry.
  - 70% are the result of nondisjunction.
- Down syndrome (trisomy 21)
  - At age 25, 1 in 1,250
  - At age 30, 1 in 1,000
  - At age 35, 1 in 400
  - At age 40, 1 in 100
  - At age 45, 1 in 30
  - At age 49, 1 in 10
- Nondisjunction may also occur in sex chromosomes



Producing Proteins: The Other Function of DNA

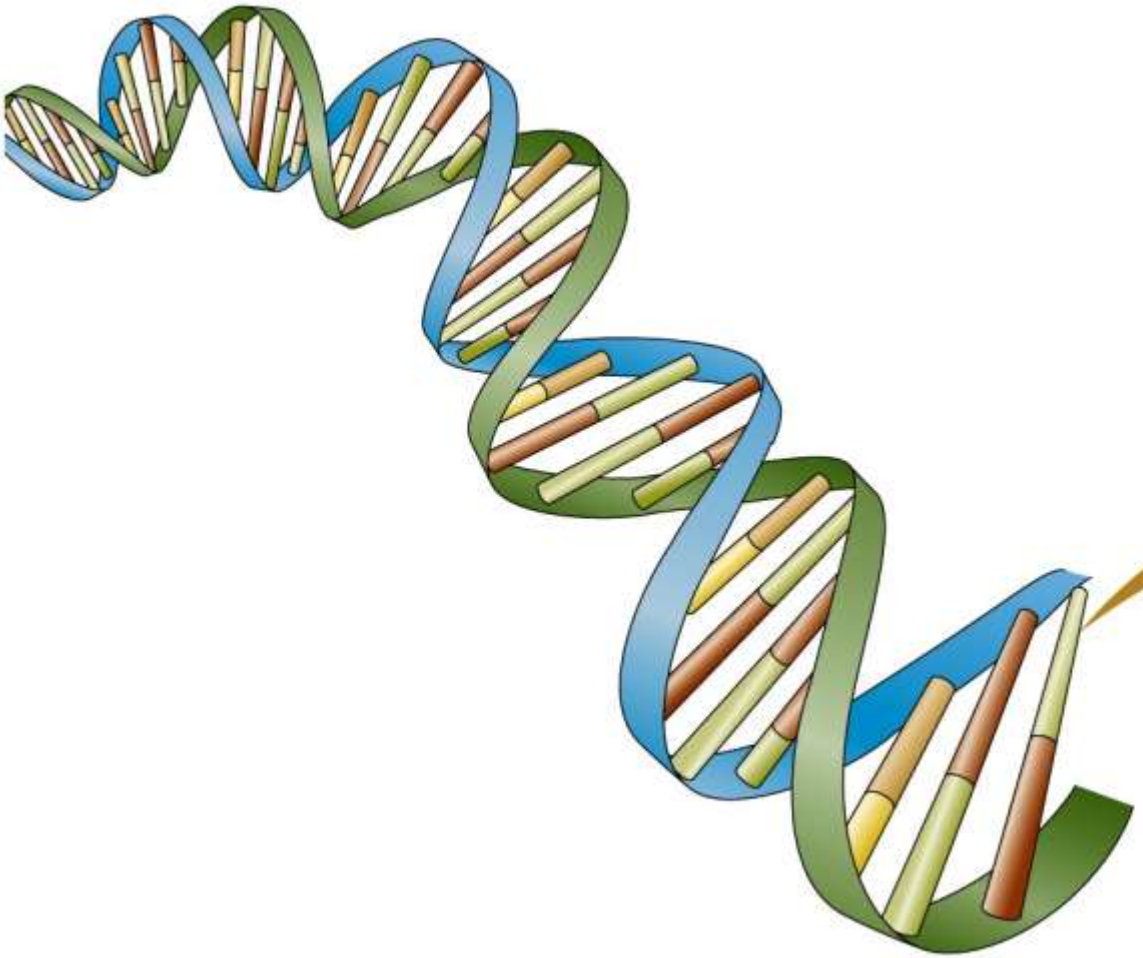
Protein Synthesis

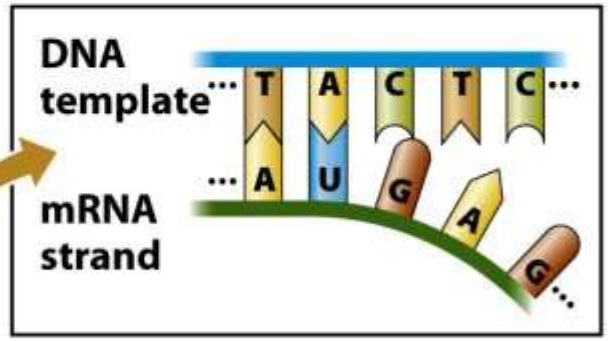
Transcription
Translation
RNA



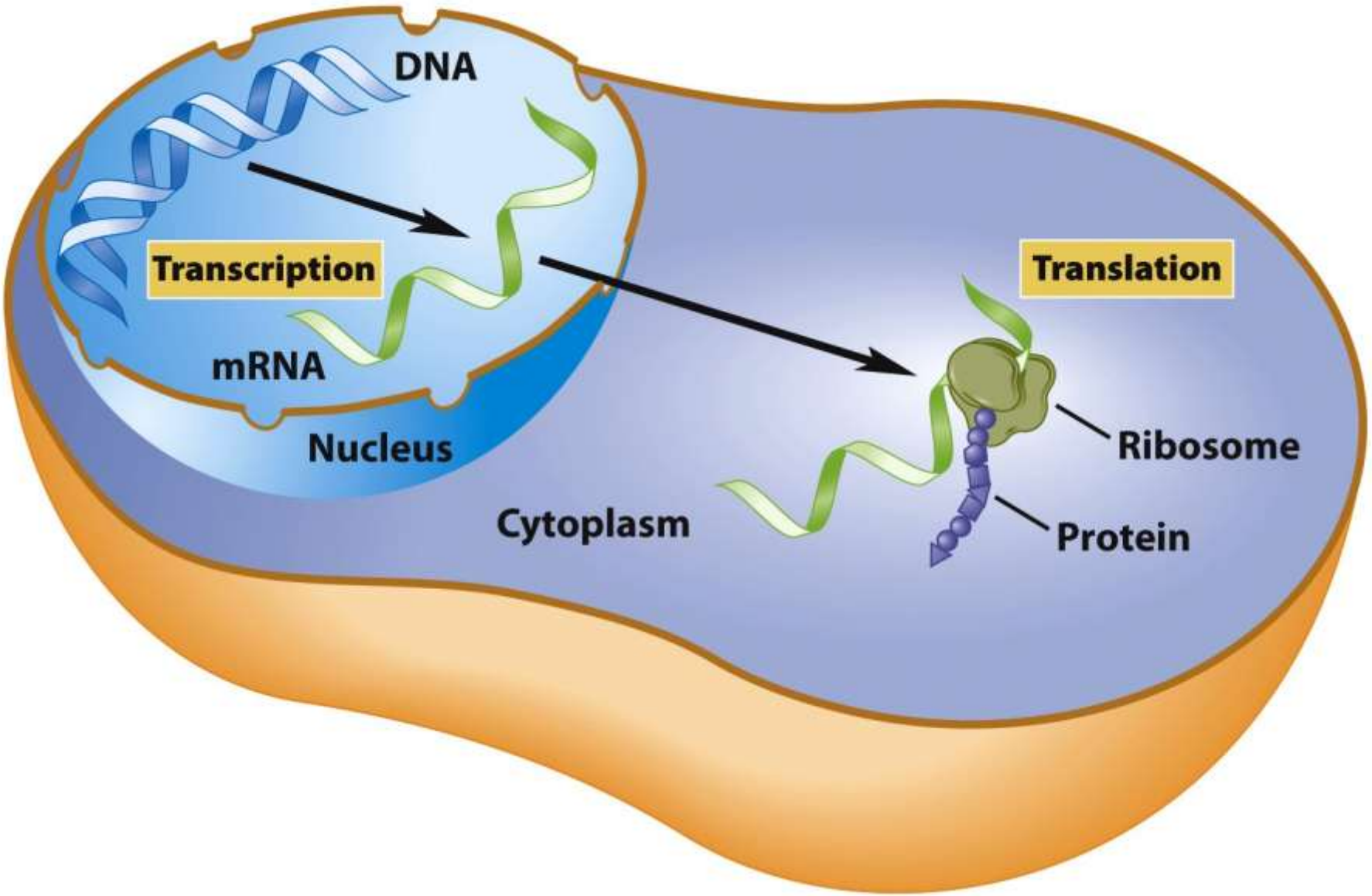
Transcription

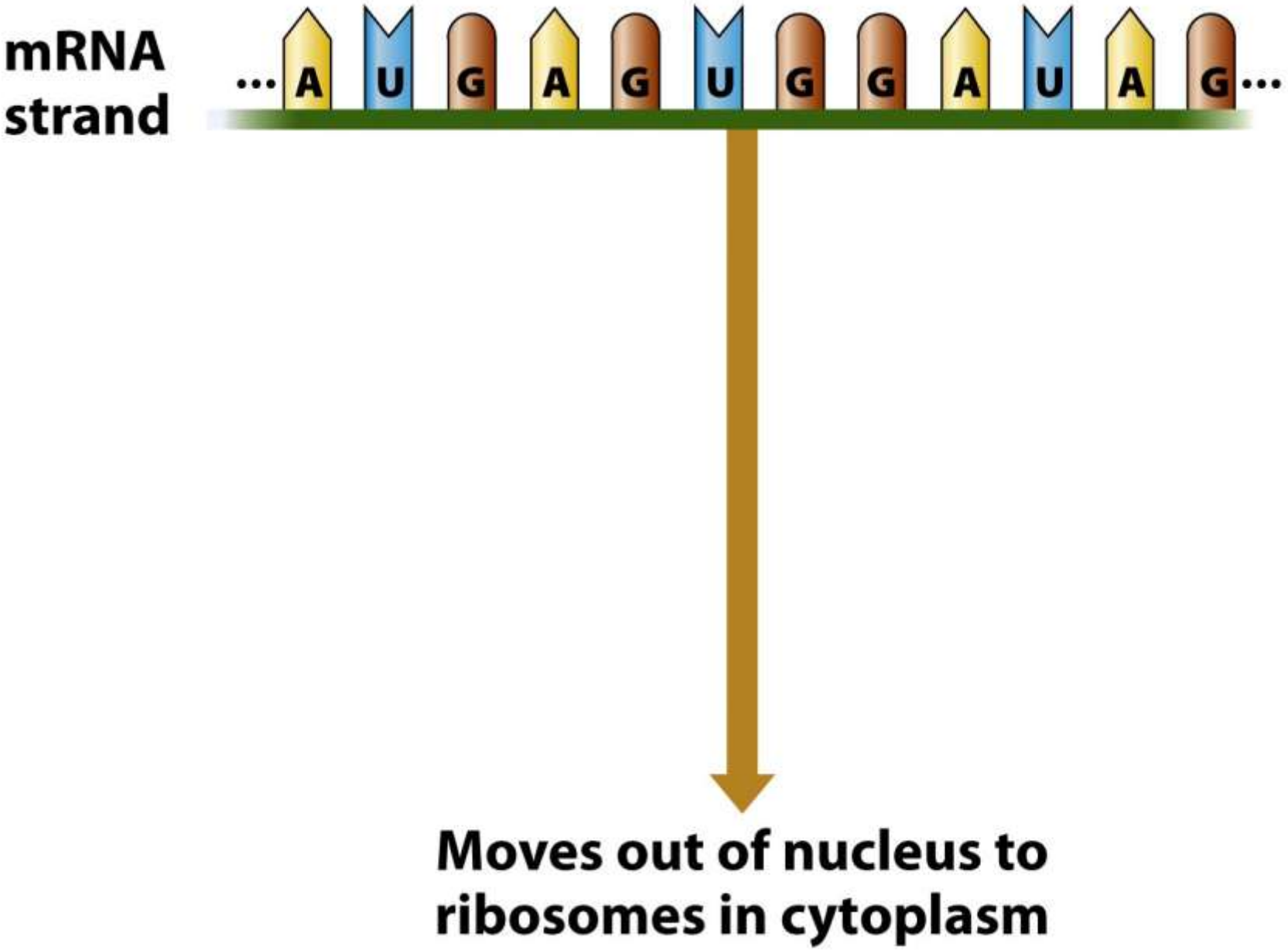
in nucleus

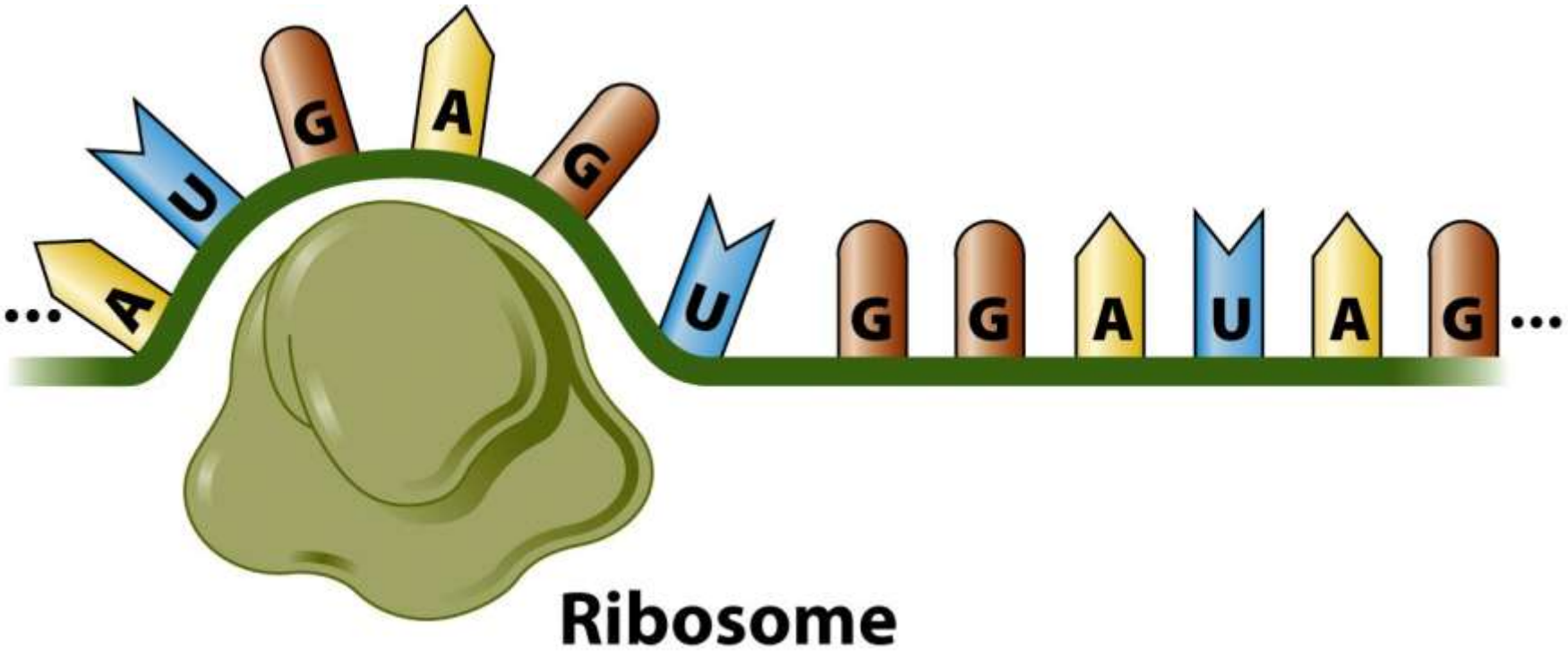




Protein Synthesis




mRNA strand
... A U G A G U G G A U A G ...
Moves out of nucleus to ribosomes in cytoplasm

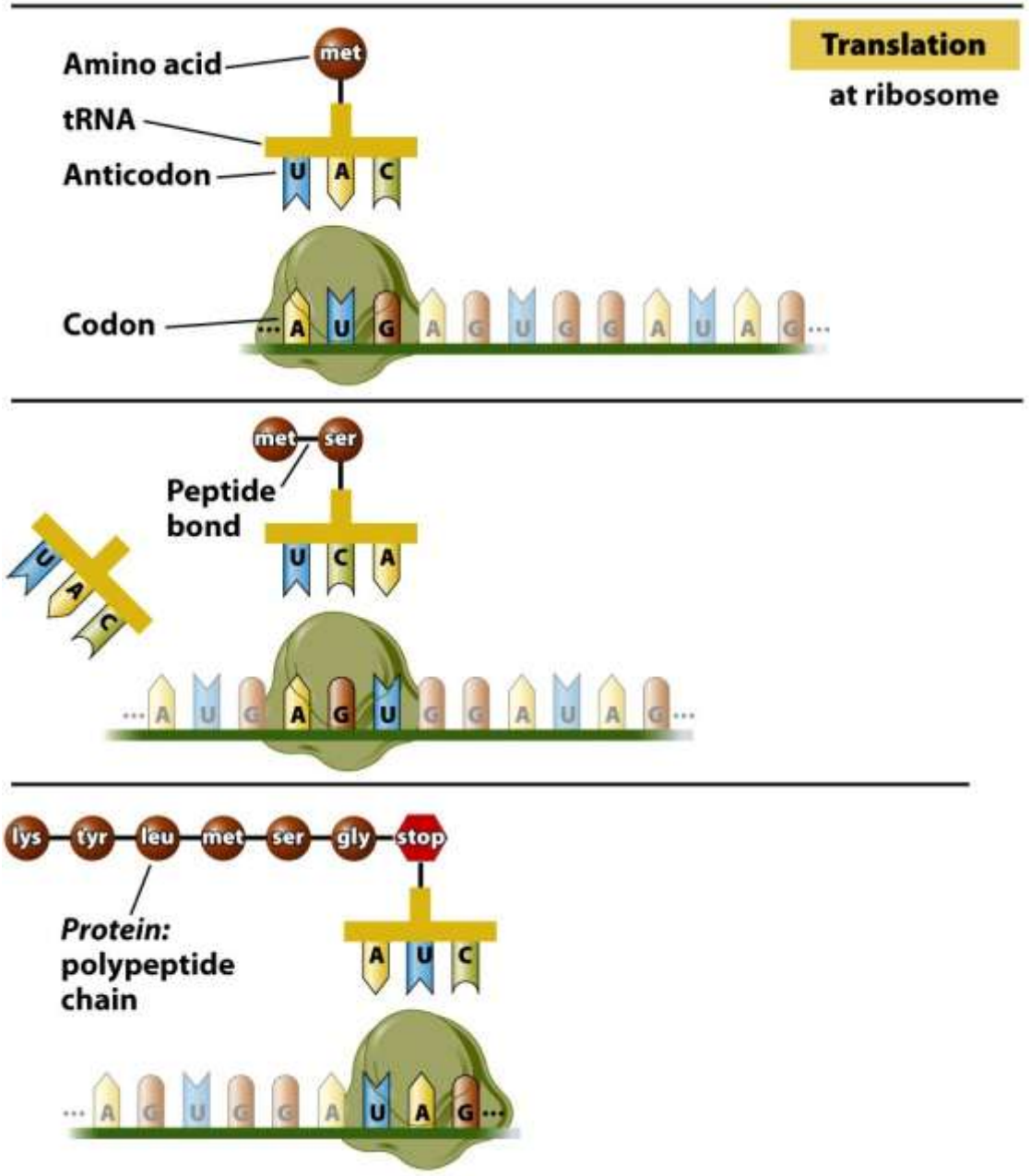


Ribosomes

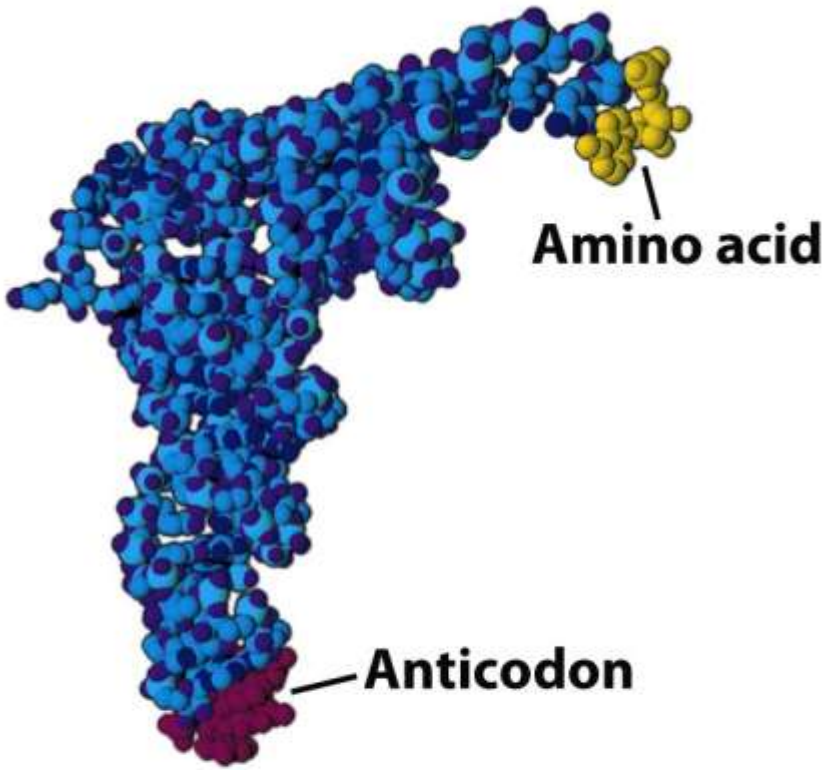
Triplets

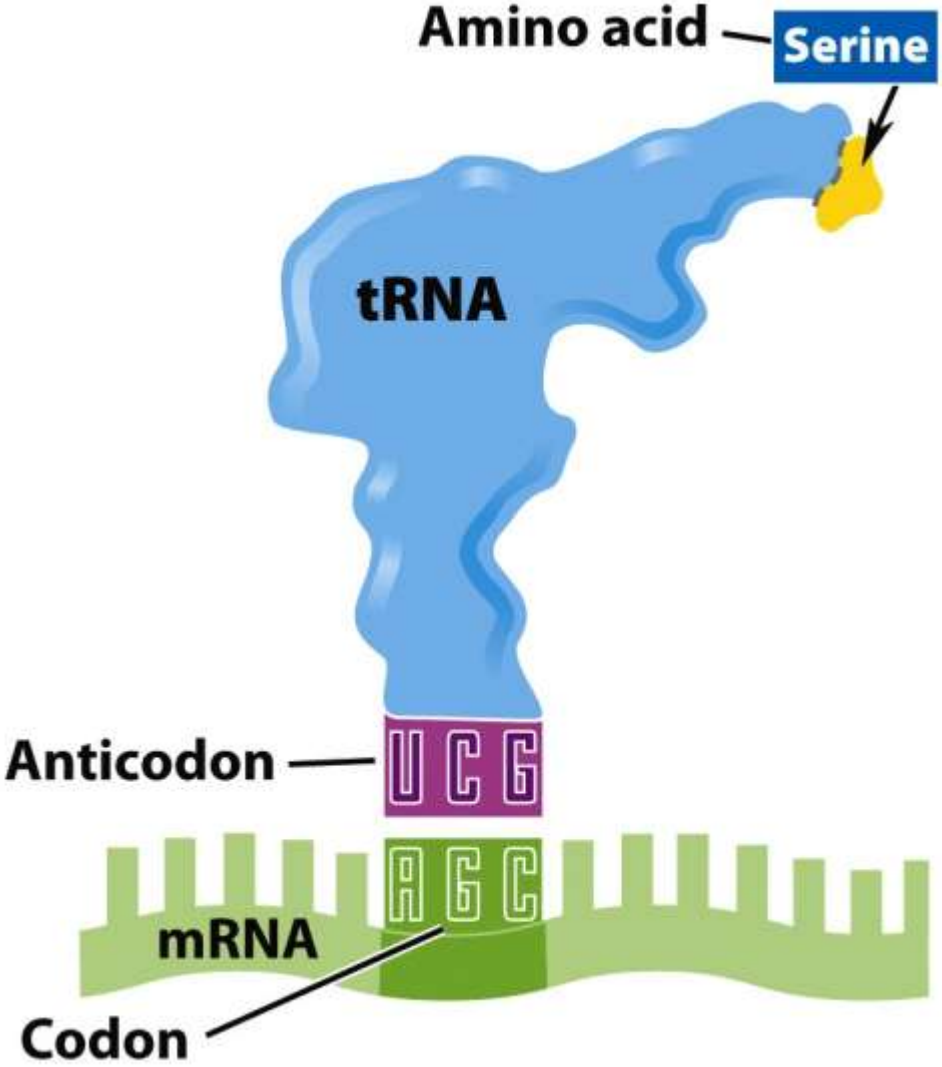
Codons

Peptide bond



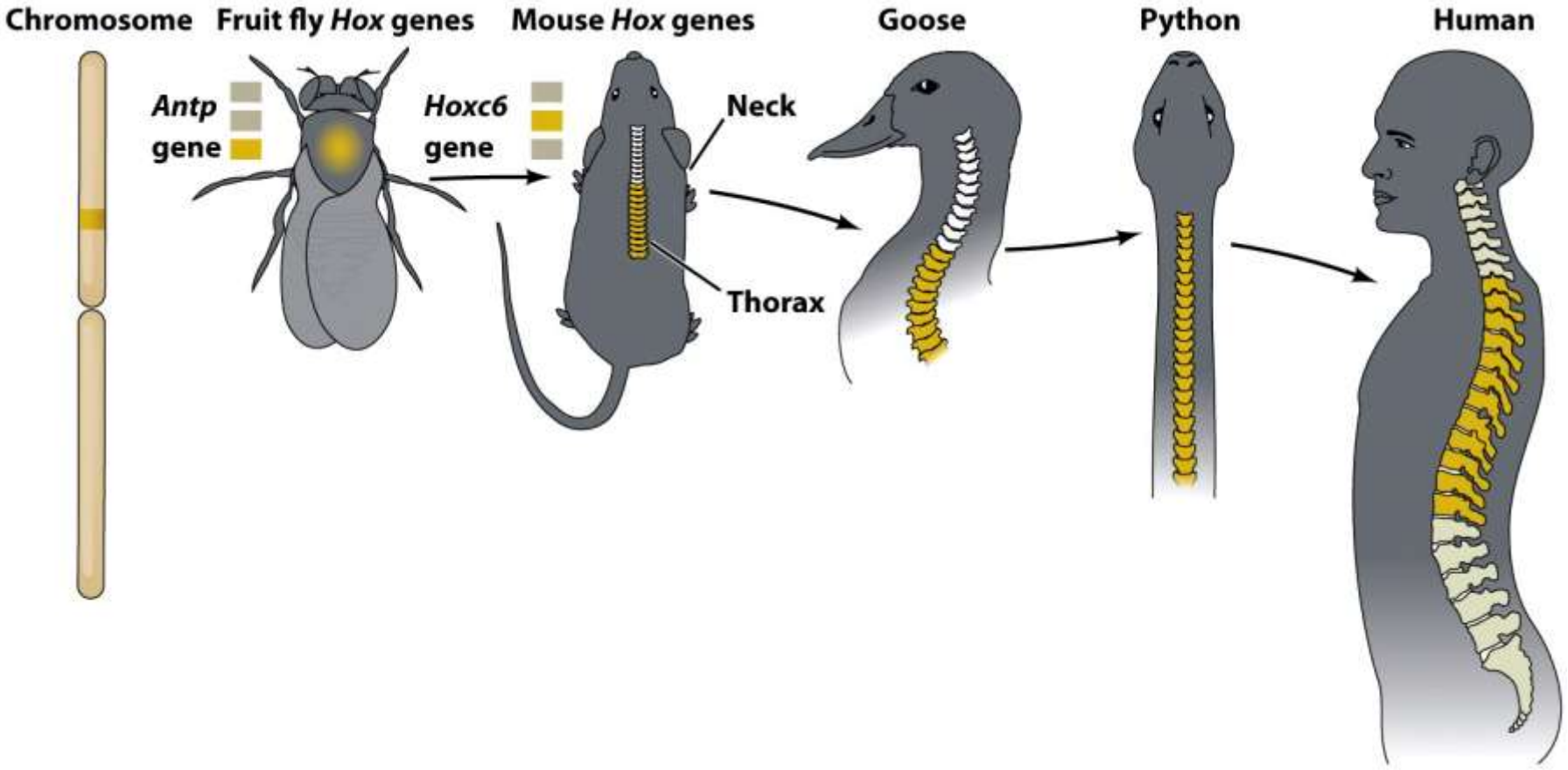
Amino Acids


Amino acid
Anticodon


Amino acid
Serine
tRNA
Anticodon
U C G
A G C
mRNA
Codon

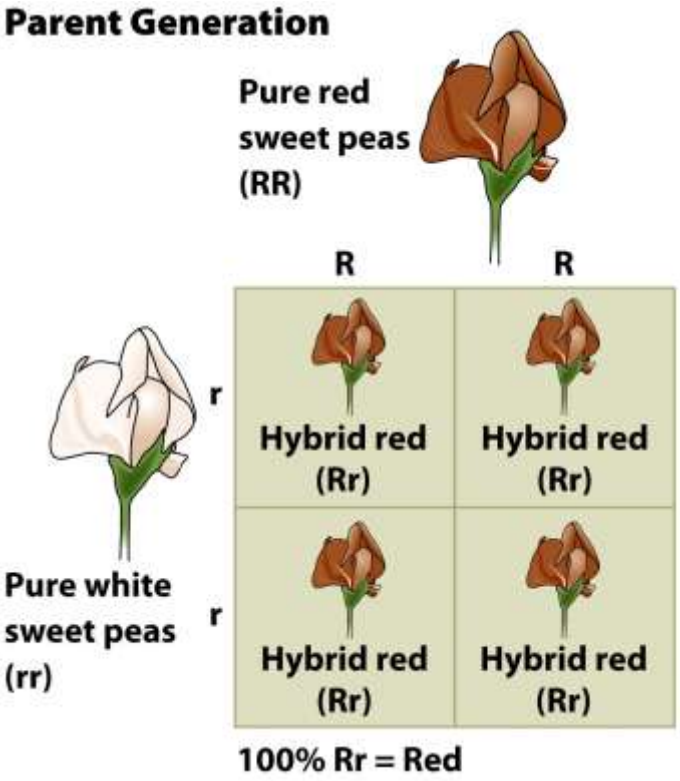
Genes: Structural and Regulatory

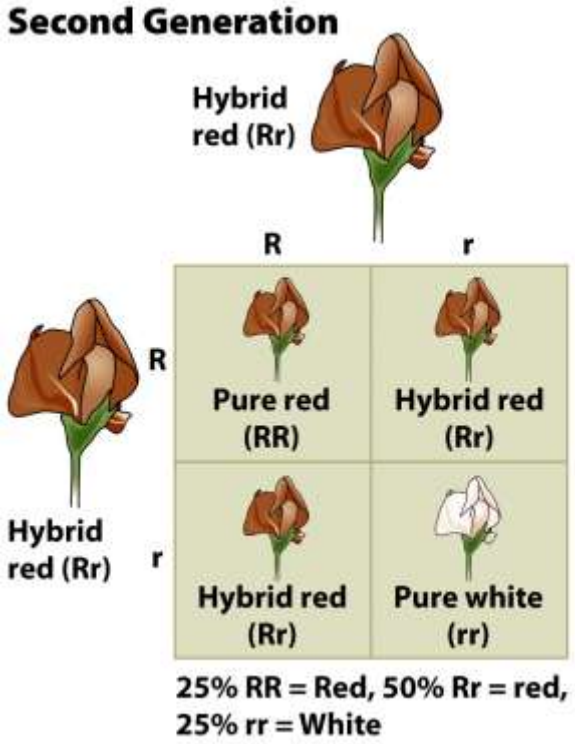
- Homeotic (Hox) Genes



Polymorphisms: Variations in Specific Genes

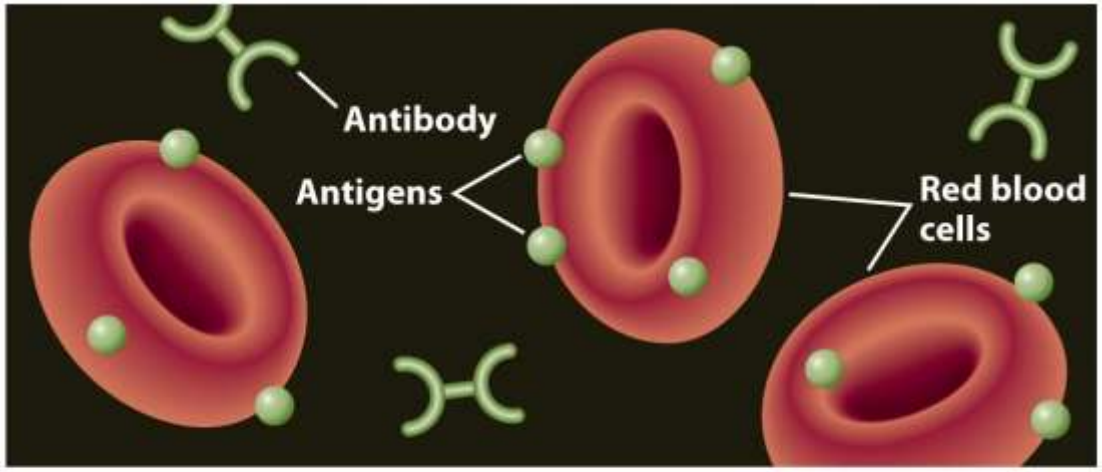
- Locus
- Law of Segregation
- Single nucleotide polymorphisms (SNPs)
- Homozygous and heterozygous

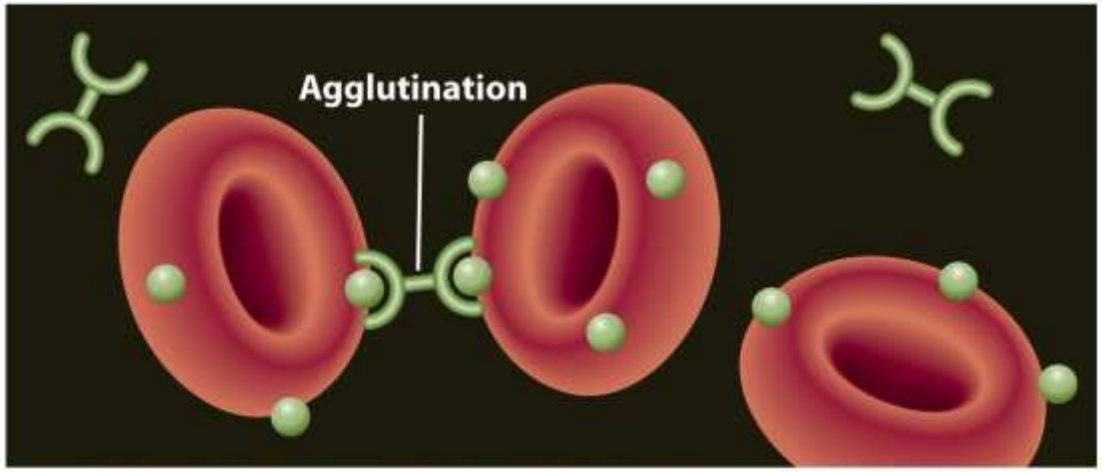




Polymorphisms: Variations in Specific Genes

- Antibodies
- Antigens
- Codominance





The Complexity of Genetics: Polygenic Variation and Pleiotropy